DR HORTON

LOW HILLS DW & PI PUMP STATION

BIDDING DOCUMENTS

MAY 2024

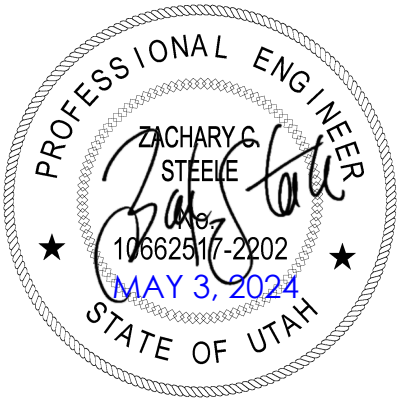
HANSEN ALLEN & LUCE inc
ENGINEERS

DR HORTON

LOW HILLS DW & PI PUMP STATION

MAY 2024

PROJECT MANUAL



Project Engineer
Zachary Steele, PE

HANSEN, ALLEN, & LUCE, INC.
Consultants/Engineers
859 West South Jordan Parkway – Ste 200
South Jordan, Utah 84095
(801) 566-5599

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SECTION 00 11 13
ADVERTISEMENT FOR BIDS

DR HORTON

12351 S Gateway Park Place

Suite D 100. Draper, UT 84020

Electronic bids (in PDF format) for the **LOW HILLS DW & PI PUMP STATION** will be received by **DR Horton,** at the email address listed below until **2:00 pm on Tuesday June 4, 2024.**

Description and Scope of Work:

The construction of a combined drinking water and pressurized irrigation pump station facility with associated transmission main pipelines, electrical supply conduit, and gas pipeline trenching. The pump station will be equipped with three vertical turbine drinking water pumps (two duty and one standby) and two pressurized irrigation vertical turbine pumps (one duty and one standby), motors and pump cans; suction and discharge pipelines, valves, flow meters, and miscellaneous fittings and appurtenances; two surge bladder tanks; masonry block building with standing seam metal roofing; HVAC system; site work including: grading, crushed rock surface placement and grading, concrete sidewalk, hydroseeding, and silt fencing; drinking water and pressurized irrigation transmission main pipelines; electrical supply conduit; trenching and trench restoration for gas supply pipeline installation by others; and connections to existing onsite piping. The project includes electrical connections to and electrical work associated with the booster pump station, installation of a new emergency generator, and control wiring for two system PLCs.

No PRE-BID CONFERENCE will be held.

All questions relative to the project shall be directed to the DR Horton on or before **Thursday May 30, 2024.**

DR Horton
12351 Gateway Park Place, Suite D-100
Draper, UT 84020
Attention: Dave Martin
Phone: 385-214-7665
Email: DLMartin2@DRHorton.com

BIDDING DOCUMENTS may be obtained in electronic PDF format from the DR Horton on or after Monday May 6, 2024.

DR Horton reserves the right to reject any or all bids submitted.

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SECTION 00 21 13
INSTRUCTIONS TO BIDDERS

ARTICLE 1 - DEFINED TERMS

1.01 Terms used in these Instructions to Bidders 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 Complete sets of the Bidding Documents may be obtained from the Issuing Office.

2.02 Complete sets of Bidding Documents shall 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.

2.03 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 authorize or confer a license for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

3.01 To demonstrate Bidder's qualifications to perform the Work, after submitting its Bid and within 14 days of Owner's request, Bidder shall submit (a) written evidence establishing its qualifications such as financial data, previous experience, and present commitments, and (b) the following additional information:

A. Evidence of Bidder's authority to do business in the state where the Project is located.

B. Bidder's state or other contractor license number, if applicable.

C. Subcontractor and Supplier qualification information; coordinate with provisions of Article 12 of these Instructions, "Subcontractors, Suppliers, and Others."

3.02 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contract.

3.03 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

3.04 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

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 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. Bidder shall conduct the required Site visit during normal working hours, and shall not disturb any ongoing operations at the Site.

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, the 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 not be held.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to DR Horton in writing via email. 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 after

May 30, 2024 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 Security is not required.

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.

A. 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. 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."

C. 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.

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 Lump Sum

A. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form.

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 With each copy of the Bidding Documents, a Bidder is furnished one copy of the Bid Form. The Bid Form is to be completed and submitted with other documents required to be submitted under the terms of Article 7 of the Bid Form.

15.02 A Bid shall be submitted no later than the date and time indicated in the Advertisement for Bids and shall be in electronic PDF format submitted by email with "Bid for LOW HILLS DW & PI PUMP STATION" as the subject line of the email. The Bid shall include the name and address of Bidder, and other required documents. Only electronical bids (PDF) shall be accepted, no hard copies will be accepted. Bids received after the date and time prescribed for the opening of bids, or not submitted in the designated manner, will not be accepted and the Bidder will be notified of such.

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. 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 indicated in the Advertisement for Bids. 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 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 be to the responsible Bidder submitting the lowest responsive Bid.

19.04 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 determination of the apparent low Bidder(s) when sectional bids are submitted, Bids will be compared on the basis of the aggregate of the Bids for separate sections and the Bids for combined sections that result in the lowest total amount for all of the Work.

19.05 In evaluating whether a Bidder is responsible, Owner will 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.

19.06 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.

20.02 I 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.

- END OF DOCUMENT –

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SECTION 00 41 00
BID FORM

Project: **DR HORTON – LOW HILLS DW & PI PUMP STATION**

ARTICLE 1 - BID RECIPIENT

1.01 This Bid is submitted to: **DR HORTON**
12351 S Gateway Park Place, Suite D-100
Draper, UT 84020

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 this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 - Bidder's Acknowledgements

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 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, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

Addendum No.	Addendum, Date
_____	_____
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and has satisfied itself 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 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. Bidder has considered 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 any 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. Bidder agrees, based on the information and observations referred to in paragraph 3.01.E, that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this 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. Bidder 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 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 confirms that 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 and furnishing of the Work.

J. The submission of this Bid constitutes an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, and 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 4 - Bidder's Certification

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive 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 e execution of the Contract.

ARTICLE 5 - Basis of Bid

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

LUMP SUM BID

Lump Sum Bid Price	$

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 damages.

ARTICLE 7 - Attachments to this Bid

7.01 The following documents are submitted with and made a condition of this Bid:

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

B. List of Proposed Subcontractors and Suppliers (Document 00 45 00);

C. List of Project References (Bidders own format);

D. Contractor’s License No.: _____

ARTICLE 8 - Defined Terms

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

ARTICLE 9 - Bid Submittal

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:

_____

SEAL,
if required by State

Second Joint Venture Name: _____

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 FAX No. (_____)_____

Business E-Mail Address _____

State Contractor License No. _____. (If applicable)

Employer's Tax ID No. _____

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

_____

_____

Bid submitted on _____, 20___.

- END OF DOCUMENT -

DOCUMENT 00 45 00
LIST OF SUBCONTRACTORS AND SUPPLIERS

In addition to those listed below the bidder shall list below the names and business address of each subcontractor or supplier 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 bids, 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.Electrical Systems	
2. Bladder Surge Tanks	
3. Vertical Turbine Pumps	
4.	
5.	
6.	

- END OF DOCUMENT -

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PART 2
CONTRACT DOCUMENTS

SECTION 00 51 00
NOTICE OF AWARD

Date: _____

Project: LOW HILLS DW & PI PUMP STATION	
Owner: DR HORTON	Owner's Contract No.:
Contract:	Engineer's Project No.: 432.07.100
Bidder:	
Bidder's Address: *[send Notice of Award Certified Mail, Return Receipt Requested]*	

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

[Indicate total Work, alternates, or sections of Work awarded.]

The Contract Price of your Contract is Dollars ($).

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 6.01), and Supplementary Conditions (Paragraph SC-6.03).
3. Other conditions precedent:

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.

Owner: **DR HORTON**

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

Copy to Engineer

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DOCUMENT 00 52 00
AGREEMENT

This Agreement is by and between DR HORTON ("Owner") and _____ ("Contractor").

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

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:

Description and Scope of Work: The construction of a combined drinking water and pressurized irrigation pump station facility with associated transmission main pipelines, electrical supply conduit, and gas pipeline trenching. The pump station will be equipped with three vertical turbine drinking water pumps (two duty and one standby) and two pressurized irrigation vertical turbine pumps (one duty and one standby), motors and pump cans; suction and discharge pipelines, valves, flow meters, and miscellaneous fittings and appurtenances; two surge bladder tanks; masonry block building with standing seam metal roofing; HVAC system; site work including: grading, crushed rock surface placement and grading, concrete sidewalk, hydroseeding, and silt fencing; drinking water and pressurized irrigation transmission main pipelines; electrical supply conduit; trenching and trench restoration for gas supply pipeline installation by others; and connections to existing onsite piping. The project includes electrical connections to and electrical work associated with the booster pump station, installation of a new emergency generator, and control wiring for two system PLCs.

ARTICLE 2 - THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: **LOW HILLS DW & PI PUMP STATION.**

ARTICLE 3 - ENGINEER

3.01 The Owner has retained Hansen, Allen, Luce, Inc. ("Engineer") to act as Owner's representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by Engineer.

ARTICLE 4 - CONTRACT TIMES

4.01 Time is of the Essence

4.02 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.

4.03 Contract Times: Days

A. The Work will be substantially complete within **180** calendar days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within **210** calendar days after the date when the Contract Times commence to run.

4.04 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 and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. 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):

B. *Substantial Completion:* Contractor shall pay Owner $**1,500** for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.

C. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $**1,500** for each day that expires after such time until the Work is completed and ready for final payment.

D. Liquidated damages for failing to timely attain Milestones, Substantial Completion, and final completion are not additive, and will not be imposed concurrently.

E. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

ARTICLE 5 - CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:

A. For all Work other than Unit Price Work, a lump sum of $_____.

All specific cash allowances are included in the above price in accordance with Paragraph 13.02 of the General Conditions.

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 the basis of Contractor's Applications for Payment on or about the 30th day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in 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 elsewhere in the Contract.

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 Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.

a. 95 percent of the value of the Work completed (with the balance being retainage).

1) If 50 percent or more of the Work has been 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 set off by Owner pursuant to Paragraph 15.01.E 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 punch list of items to be completed or corrected prior to final payment.

6.03 Final Payment

A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 Consent of Surety

A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

ARTICLE 7 - CONTRACT DOCUMENTS

7.01 Contents

A. The Contract Documents consist of all of the following:

1. This Agreement.
2. Bonds:

    a. Performance bond (together with power of attorney).
    b. Payment bond (together with power of attorney).

3. General Conditions.
4. Supplementary Conditions.
5. Specifications as listed in the table of contents of the project manual (copy of list attached).
6. Drawings
7. Drawings listed on the attached sheet index.
8. Addenda (numbers _____ to _____, inclusive).
9. Exhibits to this Agreement (enumerated as follows):

    a. _____

10. The following which may be delivered or issued on or after the Effective Date of the Contract 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 Contract Documents listed in Paragraph 7.01.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 7.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 8 - REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 Contractor's Representations

A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:

1. Contractor has examined and carefully studied the Contract Documents, including Addenda.
2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.

4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Contractor has considered the information known to Contractor itself; 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 Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no 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.
8. 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.
9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 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 8.02:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything 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.

8.03 Standard General Conditions

A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or “track changes” (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

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

Owner:

DR HORTON
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone:

Email:

*(If **[Type of Entity]** is a corporation, attach evidence of authority to sign. If **[Type of Entity]** is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)*

Contractor:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

*(If **[Type of Entity]** is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone:

Email:

License No.: _____
(where applicable)

State: _____

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DOCUMENT 00 55 00
NOTICE TO PROCEED

Owner:	DR HORTON	Owner's Project No.:	
Engineer:		Engineer's Project No.:	432.07.100
Contractor:		Contractor's Project No.:	
Project:	LOW HILLS DW & PI PUMP STATION		
Contract Name:			
Effective Date of Contract:			

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on _____ pursuant to Paragraph 4.01 of the General Conditions.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.

In accordance with the Agreement:

The number of days to achieve Substantial Completion is **180 calendar days, from Agreement** from the date stated above for the commencement of the Contract Times, resulting in a date for Substantial Completion of _____; and the number of days to achieve readiness for final payment is **210 calendar days, from Agreement** from the commencement date of the Contract Times, resulting in a date for readiness for final payment of _____**.**

_____**.**Before starting any Work at the Site, Contractor must comply with the following:

Nothing Further

Owner:	**DR HORTON**
By *(signature)*:	
Name *(printed)*:	
Title:	
Date Issued:	

Copy to Engineer

- END OF DOCUMENT -

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SECTION 00 61 00
PERFORMANCE BOND

SURETY Name: Address *(principal place of business)*:
CONTRACTOR Name: Address *(principal place of business)*:
OWNER Name: **DR Horton** Address *(principal place of business)*: 12351 S Gateway Park Place, Suite D 100, Draper, UT 84020
CONTRACT Effective Date of Agreement: Amount: Description:
Bond Bond Amount: Date of Bond: *(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	
	_____ *(Contractor's Name and Corporate Seal)*		_____ *(Surety's Name and 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 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.

2.1 If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:

2.2 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;

2.3 The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

2.4 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.

3 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.

4 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:

4.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

4.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

4.3 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

4.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

4.4.1. 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

4.4.2. Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

5 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.

6 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:

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

6.2 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

6.3 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.

7 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.

8 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.

9 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.

10 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.

11 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.

12 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.

13 Definitions

13.1 *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.

13.2 *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.

13.3 *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.

13.4 *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.

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

14 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.

15 Modifications to this Bond are as follows: None

SECTION 00 61 50
PAYMENT BOND

SURETY Name: Address *(principal place of business)*:
CONTRACTOR Name: Address *(principal place of business)*:
OWNER Name: **DR Horton** Address *(principal place of business)*: 12351 S Gateway Park Place, Suite D 100, Draper, UT 84020
CONTRACT Effective Date of Agreement: Amount: Description:
Bond Bond Amount: Date of Bond: *(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	
	_____ *(Contractor's Name and Corporate Seal)*		_____ *(Surety's Name and 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: None

- END OF SECTION -

SECTION 00 62 50
CERTIFICATE OF SUBSTANTIAL COMPLETION

Project: LOW HILLS DW & PI PUMP STATION	
Owner: DR Horton	Owner's Contract No.:
Contract:	Engineer's Project No.: 432.07.100

This [tentative] [definitive] Certificate of Substantial Completion applies to:

☐ All Work under the Contract Documents: ☐ 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 Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

A [tentative] [definitive] list of items to be completed or corrected is attached hereto. 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.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:

☐ Amended Responsibilities ☐ Not Amended

Owner's Amended Responsibilities:

Contractor's Amended Responsibilities:

The following documents are attached to and made 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 41
CHANGE ORDER

CHANGE ORDER NO.:

Owner: **DR Horton** Owner's Project No.:

Engineer: Engineer's Project No.: 432.07.100

Contractor: Contractor's Project No.:

Project: **LOW HILLS DW & PI PUMP STATION**

Contract Name:

Date Issued: Effective Date of Change Order:

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

Description:

Attachments:

Change in Contract Price	**Change in Contract Times**
Original Contract Price: $ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] from previously approved Change Orders No. 1 to No. **[Number of previous Change Order]**: $ _____	**[Increase] [Decrease]** from previously approved Change Orders No.1 to No. **[Number of previous Change Order]**: Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: $ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] this Change Order: $ _____	**[Increase] [Decrease]** this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: $ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

	Recommended by Engineer (if required)	Authorized by Owner
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

	Authorized by Owner	Approved by Funding Agency (if applicable)
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

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PART 3
CONTRACT CONDITIONS

SECTION 00 70 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.

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

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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

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

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.

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.

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.

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.

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

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.

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

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.

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

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.

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.

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

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.

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

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;

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

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

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

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

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

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.

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);

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

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.

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.

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;

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.

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.

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.

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.

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.

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.

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.

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

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.

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

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.

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.

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.

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.

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.

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.

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.

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.

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:

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.

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

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

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

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

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.

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

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

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.

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,

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,

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

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.

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;

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

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

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.

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,

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.

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,

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

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.

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.

SECTION 00 80 00
SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (No. EJCDC C-700, 2018 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.

SC-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, 2018 Edition) have the meanings assigned to them in the General Conditions.

SC-2.02 COPIES OF DOCUMENTS

Delete Paragraph 2.02 of the General Conditions and insert the following in its place:

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.

SC-3.03 REPORTING AND RESOLVING DISCREPANCIES

Add the following new paragraph immediately after paragraph 3.03.B:

3.03.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.

SC-4.01 COMMENCEMENT OF CONTRACT TIME; NOTICE TO PROCEED

Delete paragraph 4.01.A of the General Conditions and insert the following in its place:

The Contract Times will commence to run on the date 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.

SC-5.03 SUBSURFACE AND PHYSICAL CONDITIONS

Add the following new paragraph(s) within paragraph 5.03.A:

4. No geotechnical report was prepared for this project.

SC-6.03 CONTRACTOR'S INSURANCE

The requirements of General Conditions paragraph 6.03 for insurance to be purchased and maintained by the CONTRACTOR, and any renewals thereof, are modified and supplemented as follows:

C. A copy of the acceptable Certificates of Insurance filed with the OWNER shall be delivered to the ENGINEER for review before any work at the site is started.
D. All liability insurance policies for the project shall include an endorsement naming the OWNER and ENGINEER as additional insured.

E. The CONTRACTOR General Liability Insurance shall be comprehensive form and shall include the following coverages:

1. Premises/Operations, collapse hazard, underground hazard, products/completed operations hazard, contractual insurance applicable to CONTRACTOR's obligations under SC 6.03 Indemnification, broad form property damage, independent contractors, and personal injury.

2. Auto Liability Insurance shall be comprehensive form and shall cover owned, hired and non-owned vehicles.

3. The limits of liability for the insurance required by paragraph 6.03 of the General Conditions shall provide the following coverages for not less than the following amounts or greater where required by Laws and Regulations:

a. Workers' Compensation, etc. under paragraphs 6.03.B.1 and B.2. of the General Conditions:

(1) State: ..... Statutory
(2) Applicable Federal: ..... Statutory
(3) Employer's Liability (Each Accident): $1,000,000

b. CONTRACTOR's Liability Insurance under paragraphs 6.03.C.1 through C.6 of the General Conditions which shall also include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of CONTRACTOR:

(1) General Aggregate (Except Products--Completed Operations)..... $1,000,000
(2) Products--Completed Operations Aggregate $1,000,000
(3) Personal and Advertising Injury (Per Person/ Organization): $1,000,000
(4) Each Occurrence (Bodily Injury and Property Damage):..... $1,000,000
(5) Property Damage liability insurance will provide Explosion, Collapse and Underground coverages where applicable.
(6) Excess Liability in Umbrella Form:
(a) General Aggregate..... $2,500,000
(b) Each Occurrence $1,000,000

c. Automobile Liability under paragraph 6.03.C.6 of the General Conditions:

(1) Bodily Injury:

(a) Each Person $1,000,000
(b) Each Accident $1,000,000

(2) Property Damage:
(a) Each Accident $1,000,000

or

(3) Combined Single Limit (Bodily Injury and Property Damage):
(a) Each Accident $1,000,000

d. The Contractual Liability coverage required by paragraph 5.04.B.4 of the General Conditions shall provide coverage for not less than the following amounts:

(1) Bodily Injury
(a) Each Accident $1,000,000
(b) Annual Aggregate $1,000,000

(2) Property Damage:
(a) Each Accident $1,000,000
(b) Annual Aggregate $1,000,000

e. Other persons or entities (other than those already listed in the General Conditions) to be included on the policy as additional insured shall include:

(1) DR Horton
(2) Lehi City
(2) Hansen, Allen & Luce, Inc. and its subconsultants
(3) Other Engineering or testing groups employed by OWNER for work at the site or this project.

SC-6.04 PROPERTY INSURANCE

SC-6.04. A. Delete paragraph 6.04.A of the General Conditions in its entirety and insert the following in its place:

A. CONTRACTOR shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof. This insurance shall:

1. Include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss and damage to the Work, temporary buildings, falsework, and materials and equipment in transit and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4 cover materials and equipment stored at the Site or at another location that was agreed to in writing by OWNER prior to being incorporated in the Work. Provided that such materials and equipment have been included in an Application for Payment recommended by ENGINEER; and

5. allow for partial utilization of the Work by OWNER;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by OWNER, CONTRACTOR and ENGINEER with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. CONTRACTOR shall be responsible for any deductible or self-insured retention.

C. The policies of insurance required to be purchased and maintained by CONTRACTOR in accordance with this paragraph SC-6.04 shall comply with the requirements of paragraph 6.04.C of the General Conditions.

SC-6.04. E. Delete paragraph 6.04 .E of the General Conditions in its entirety.

SC - 7.13 SAFETY AND PROTECTION

Add the following language at the end of the first sentence of the first paragraph of 7.13 of the General Conditions:

In particular the CONTRACTOR shall be responsible for observing and supervising all safety precautions in accordance with regulations established by the Occupational Safety and Health Administration (OSHA).

SC-7.18 INDEMNIFICATION

Paragraphs 7.18.A, & B of the General Conditions shall be deleted in their entirety and replaced with the following:

A. To the fullest extent permitted by law, the CONTRACTOR shall indemnify and hold harmless the OWNER and the ENGINEER and their agents and employees from and against all claims, damages, losses and expense including but not limited to attorney's fees arising out of or resulting from the performance of the work, provided that any such claim, damage, loss or expense (a) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting therefrom, and (b) is caused in whole or in part by any negligent act, errors or omission of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, regardless of whether or not it is caused by a party indemnified hereunder.

B. In any and all claims against the OWNER or the ENGINEER or any of their agents or employees by an employee of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this paragraph shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the CONTRACTOR or any SUBCONTRACTOR under worker's compensation acts, disability benefit acts or other employee benefit acts.

C. The obligations of the CONTRACTOR under subparagraph SC-7.18.A above, shall not extend to the liability of the ENGINEER, his agents or employees arising out of the preparation or approval of maps, drawings, opinions, reports, surveys, change orders, designs or specifications.

SC-8.02 COORDINATION

Add a new paragraph immediately after paragraph 8.02 of the General Conditions which is to read as follows:

B. 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 12. 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.

SC-10.03 RESIDENT PROJECT REPRESENTATIVE

Add the following language to section 10.03 of the General Conditions.

1. ENGINEER may furnish a full time Resident Project Representative (RPR) to represent ENGINEER at the project site. The duties and responsibilities of the RPR are limited to those of ENGINEER in ENGINEER's agreement with OWNER and in the construction Contract documents, and are further limited and described as follows:

A. General

RPR is ENGINEER's agent at the site, will act as directed by and under the supervision of ENGINEER, and will confer with ENGINEER regarding RPR's actions. RPR's dealings in matters pertaining to the on-site work shall in general be with ENGINEER and CONTRACTOR keeping OWNER advised as necessary. RPR's dealings with subcontractors shall only be through or with the full knowledge and approval of CONTRACTOR. RPR shall generally communicate with OWNER with the knowledge of and under the direction of ENGINEER.

B. Duties and Responsibilities of RPR

1. Schedules: Review the progress schedule, schedule of Shop Drawing submittals and schedule of values prepared by CONTRACTOR and consult with ENGINEER concerning acceptability.

2. 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.

3. Liaison:

    a. Serve as ENGINEER's liaison with CONTRACTOR, working principally through CONTRACTOR's superintendent and assist in understanding the intent of the Contract Documents; and assist ENGINEER in serving as OWNER's liaison with CONTRACTOR when CONTRACTOR's operations affect OWNER's on-site operations.

    b. Assist in obtaining from OWNER additional details or information, when required for proper execution of the Work.

4. Shop Drawings and Samples:

    a. Record date of receipt of Shop Drawings and samples.

    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 Work requiring a Shop Drawing or sample if the submittal has not been approved by ENGINEER.

5. Review of Work, Rejection of Defective Work, Inspections and Tests:

   a. Conduct on-site observations of the work in progress to assist ENGINEER in determining if the Work is in general proceeding in accordance with the Contract Document.

   b. Report to ENGINEER whenever RPR believes that any Work is unsatisfactory, faulty or defective or does not conform to 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 Work that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

   c. Verify that tests, equipment and systems startups and operating and maintenance training are conducted in the presence of appropriate personnel, and that CONTRACTOR maintains adequate records thereof; and observe, record and report to ENGINEER appropriate details relative to the test procedures and startups.

   d. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the results of these inspections and report to ENGINEER.

6. 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.

7. Modifications: Consider and evaluate CONTRACTOR's suggestions for modifications in Drawings or Specifications and report with RPR's recommendations to ENGINEER. Transmit to CONTRACTOR decisions as issued by ENGINEER.

8. Records:

   a. Maintain at the job site orderly files for correspondence, reports of job conferences, Shop Drawings and samples, reproductions of original Contract Documents including all Work Directive Changes, Addenda, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the Contract, ENGINEER's clarifications and interpretations of the Contract Documents, progress reports, and other Project related documents.

   b. Keep a diary or log book, recording CONTRACTOR hours on the job site, weather conditions, data relative to questions of Work Directive Changes, Change Orders or changed conditions, list of job site visitors, 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.

c. Record names, addresses and telephone numbers of all CONTRACTORS, subcontractors and major suppliers of materials and equipment.

9. Reports:

   a. Furnish 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. Consult with ENGINEER in advance of scheduled major tests, inspections or start of important phases of the Work.

   c. Draft proposed Change Orders and Work Directive Changes, obtaining backup material from CONTRACTOR and recommend to ENGINEER Change Orders, Work Directive Changes, and Field Orders.

   d. Report immediately to ENGINEER and OWNER upon the occurrence of any accident.

10. 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.

11. Certificates, Maintenance and Operation Manuals: During the course of the Work, verify that certificates, maintenance and operation manuals and other data required to be assembled and furnished by CONTRACTOR are applicable to the items actually installed and in accordance with the Contract Documents, and have this material delivered to ENGINEER for review and forwarding to OWNER prior to final payment for the Work.

12. Completion:

   a. Before ENGINEER issues a Certificate of Substantial Completion, submit to CONTRACTOR a list of observed items requiring completion or correction.

   b. Conduct final inspection in the company of ENGINEER, OWNER, and CONTRACTOR and prepare a final list of items to be completed or corrected.

   c. Observe that all items on final list have been completed or corrected and make recommendations to ENGINEER concerning acceptance.

SC-10.07 Limitations on Engineer's Authority and Responsibilities

Add the following language to section 10.07 of the General Conditions.

Resident Project Representative:

1. Shall not authorize any deviation from the Contract Documents or substitution of materials or equipment, unless authorized by ENGINEER.

2. Shall not exceed limitations of ENGINEER's authority as set forth in the Agreement or the Contract Documents.

3. Shall not undertake any of the responsibilities of CONTRACTOR, subcontractors or CONTRACTOR's superintendent.

4. Shall not advise on, issue directions relative to or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction unless such advice or directions are specifically required by the Contract Documents.

5. Shall not advise on, issue directions regarding or assume control over safety precautions and programs in connection with the Work.

6. Shall not accept Shop Drawings or sample submittals from anyone other than CONTRACTOR.

7. Shall not authorize OWNER to occupy the Project in whole or in part.

8. Shall not participate in specialized field or laboratory tests or inspections conducted by others except as specifically authorized by ENGINEER.

SC-13.03 UNIT PRICE WORK

Paragraph 13.03.E of the General Conditions is hereby deleted in its entirety and the following is substituted in lieu thereof:

E. The unit price of an item of Unit Price Work shall be subject to re-evaluation and adjustment under the following conditions:

1. If the total cost of a particular item of Unit Price Work amounts to 25% or more of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by CONTRACTOR differs by more than 25% 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; or if OWNER believes that the quantity variation entitles OWNER to an adjustment in the unit price, either OWNER or CONTRACTOR may make a claim for an adjustment in the Contract Price in accordance with Article 10 if the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

SC-15.01.B APPLICATIONS FOR PAYMENT

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 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. All applications for payment shall be accompanied by partial lien releases on the project from all Subcontractors, Employees, Suppliers, and Contractors who have pre-liened the work.

SC-15.01.D PAYMENT BECOMES DUE

Paragraph 15.01.D of the General Conditions is hereby deleted in its entirety and the following is substituted in lieu thereof:

ENGINEER will, within ten days after receipt of each Application for Payment, 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. Twenty days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, but not prior to the day indicated in Section 5.1 of the "Agreement", the amount recommended will (subject to the provisions of the last sentence of paragraph 14.07) become due and when due will be paid by OWNER to CONTRACTOR.

- END OF SECTION -

PART 4
TECHNICAL SPECIFICATIONS

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

A. *The construction of a combined drinking water and pressurized irrigation pump station facility with associated transmission main pipelines, electrical supply conduit, and gas pipeline trenching. The pump station will be equipped with three vertical turbine drinking water pumps (two duty and one standby) and two pressurized irrigation vertical turbine pumps (one duty and one standby), motors and pump cans; suction and discharge pipelines, valves, flow meters, and miscellaneous fittings and appurtenances; two surge bladder tanks; masonry block building with standing seam metal roofing; HVAC system; site work including: grading, crushed rock surface placement and grading, concrete sidewalk, hydroseeding, and silt fencing; drinking water and pressurized irrigation transmission main pipelines; electrical supply conduit; trenching and trench restoration for gas supply pipeline installation by others; and connections to existing onsite piping. The project includes electrical connections to and electrical work associated with the booster pump station, installation of a new emergency generator, and control wiring for two system PLCs.*

B. The Work is located at approximately N 40.442° and W 111.822°, south-east of Maple Hollow in Lehi, Utah.

1.3 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump sum 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 of 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 01 45 00 Quality Control and Materials Testing and Section 01 45 23 Testing and Inspection Services 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.

G. Construction work may only be performed between the hours of 7am to 9pm, Monday thru Friday unless specific approval is obtained from the City of Lehi for night and/or weekend work.

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

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.

1.1 BASE BID SCHEDULE

A. BID ITEM - "BOOSTER PUMP STATION"

1. **GENERAL** This bid item covers all costs associated with the Work including CONTRACTOR's cost for all labor, equipment, materials, and general and miscellaneous responsibilities and operations required for construction of a booster pump station including but not limited to pump station structure complete; piping and valving; vertical turbine pumps; electrical and control systems, generator; water transmission pipelines, gas supply trenching and restoration, electrical service conduit, and fiber optic conduit; construction surveying; quality control testing; permitting; silt fence installation; site embankment; site restorations including hydroseeding and crushed rock surface; and any and all incidentals or procedures required to complete the Work as specified herein and shown on the Contract Drawings.

2. **METHOD OF MEASUREMENT** This item shall not be measured but shall be paid for on a lump sum basis for completion of the Work.

3. **BASIS OF PAYMENT** Payment will be made at the contract lump sum bid price. Payments will be made based on the Schedule of Values as described in Section 00 70 00, General Conditions.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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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, Lehi City, 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 organizations to minimize mutual interference.

E. All existing Lehi City waterlines and service connections shall remain active during the construction of this project. 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/from the Low Hills Irrigation Pond and the Low Hills Drinking Water Tanks may not be interrupted at the same time and connections to the existing pipelines associated with these facilities may only be made during the off-peak season of November 1 to March 1. CONTRACTOR shall provide a notice to Lehi City a minimum of 7 days prior to pipeline shutdown and connections and shall only be allotted a maximum interruption time of 8 hours for each connection.

1.2 FIELD ENGINEERING

A. Construction staking and surveying shall be performed by a registered Land Surveyor in the State of Utah.

B. CONTRACTOR shall provide all survey construction staking as necessary to complete the required work according to the Contract Documents.

C. 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.

D. CONTRACTOR shall locate and protect survey control and reference points. Promptly notify ENGINEER of discrepancies discovered.

E. Control datum for survey is that shown on Contract Drawings.

F. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

G. Promptly report to ENGINEER loss or destruction of reference point or relocation required because of changes in grades or other reasons.

H. CONTRACTOR shall be responsible to coordinate with all property owners to determine the location of existing sewer and water service laterals. CONTRACTOR shall be responsible to coordinate with all property owners during installation or relocation of existing service laterals.

I. 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 4 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.

1.5 BUILDING PERMIT

A. The OWNER shall be responsible for obtaining the building permit with the City of Lehi.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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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.

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. General

1. This Section outlines the general terms that CONTRACTOR must follow for preparing and providing Submittals to ENGINEER for review.
2. CONTRACTOR shall anticipate resubmitting Submittals for major equipment or complex systems.
3. If CONTRACTOR has questions about submittal requirements, CONTRACTOR is encouraged to communicate with ENGINEER to discuss requirements prior to submitting the Submittal.
4. Substitutions shall be clearly identified on the Submittal transmittal form and shall include all the information required per Section 01 60 00 – Product Requirements.

B. Wherever Submittals are required by the Contract Documents, transmit 5 copies of each Submittal or a single electronic PDF file to ENGINEER with a Submittal transmittal form which is acceptable to ENGINEER.

C. Sequentially number transmittal forms. Mark revised Submittals with original number and sequential alphabetic or numeric suffix, i.e., Submittal 1, Submittal 1.A, Submittal 1.1, etc.

D. Identify Project, Contractor, subcontractor and/or supplier, pertinent drawing and detail number, and Specification section number, appropriate to Submittal.

E. Each Submittal shall contain material pertaining to no more than one equipment or material item.

F. Each Submittal shall have the Specification section and applicable paragraph number clearly identified on the front of the Submittal transmittal form. A copy of the Specification section and applicable paragraph shall be included with the Submittal and items included shall be clearly mark as either in compliance or not in compliance. For items not in compliance a description shall be provided explaining the reason for non-compliance.

G. 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.

H. Schedule Submittals to expedite Project and deliver to ENGINEER at their business address. Coordinate submission of related items.

I. 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.

J. Identify variations from Contract Documents and product or system limitations which may adversely affect successful performance of completed Work.

K. If a Submittal is returned to CONTRACTOR marked “APPROVED”, or similar notification, formal revision and resubmission will not be required.

L. 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.

M. 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.

N. 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.

O. Distribute copies of reviewed Submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

P. Submittals not requested will not be recognized or processed.

Q. 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.

R. 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”.

S. 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 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.

1.2 ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
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.
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
BBC	Basic Building Code, Building Officials and Code Administrators International
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
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
FHWA	Federal Highway Administration
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
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization of Standardization
ITE	Institute of Traffic Engineers
LPI	Lightning Protection Institute
LRQA	Lloyd’s Register Quality Assurance
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
RCRA	Resource Conservation and Recovery Act
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
UDOT	Utah Department of Transportation
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPRR	Union Pacific Railroad
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcements Institute, Inc.
WWPA	Western Wood Products Association

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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.

B. This Section covers scope of work to be completed by CONTRACTOR procured Testing agency and testing for quality control and material testing as well as those services to be provided by OWNER provided Special Inspector.

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 except where Special Inspections are required as defined herein. 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 SPECIAL INSPECTOR

A. All subgrade inspections, structural backfill quality control testing, and concrete observations and testing relating to the pump station and generator enclosure shall be provided by OWNER’s Special Inspector in accordance with building permit and IBC requirements. All concrete testing required on the project shall be provided by the Special Inspector. All other required testing agency and testing for quality control and material testing shall be furnished by CONTRACTOR as defined herein.

B. Contractor shall provide a 24-hour minimum notice to Special Inspector for all required inspections and tests.

1.8 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.

1.9 AUTHORITY AND DUTIES OF PROJECT REPRESENTATIVE

A. Refer to Section 00 73 00 "Supplementary Conditions" sub-section SC 10.03 "Resident Project Representative".

1.10 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.

1.11 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 1,000 square feet per 1.5 feet of backfill thickness placed.
	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.
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.
	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 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.

- END OF SECTION -

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 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
4. Special Inspector Coordination

B. All concrete testing on the project shall be provided by the Special Inspector.

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 SPECIAL INSPECTOR

A. CONTRACTOR shall be responsible for coordinating all special inspections including inspections, observations, tests, and sampling as defined on Sheets S-3 and S-4 of the Contract Drawings. CONTRACTOR shall provide a minimum of 48 hours notice prior to any required special inspections.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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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 install silt fence as shown on Contract Drawings and shall complying with all City, State, and Federal storm water management regulations and requirements and all the requirements of the Storm Water Pollution Prevention Plan (SWPPP) as prepared and provided by the Owner.

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 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 lump-sum price.

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 lump-sum price.

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 lump-sum price.

1.6 PERMITS

A. CONTRACTOR shall provide all necessary permits for completion of the Work. Values shall be included in the lump-sum price.

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 rights-of-way video in electronic format on a digital video disc (DVD) or solid-state drive (USB or Thumb Drive) before construction begins.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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, warrantee, 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: DR HORTON
12351 S Gateway Park Place
Suite D 100. Draper, UT 84020

PROJECT: LOW HILLS DW & PI PUMP STATION

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: DR HORTON
12351 S Gateway Park Place
Suite D 100. Draper, UT 84020

PROJECT: LOW HILLS DW & PI PUMP STATION

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) LOW HILLS DW & PI PUMP STATION in the City of Lehi, County of Utah, State of Utah, of which City of Lehi 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: LOW HILLS DW & PI PUMP STATION

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):

DR HORTON
12351 S Gateway Park Place
Suite D 100. Draper, UT 84020

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 DR Horton to furnish labor and materials under a contract dated _____ for the project LOW HILLS BOOSTER PUMP STATION in the City of Lehi, County of Utah, 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 DR Horton to furnish labor and materials under a contract dated _____ for the project named LOW HILLS BOOSTER PUMP STATION in the City of Lehi, County of Utah, 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 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

1.4 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.

1.5 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 a drinking water 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 non-staining 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.

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 AND CONSTRUCTION JOINTS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the work necessary to furnish, install and complete expansion and construction joints.

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. 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. Certificates of compliance stating that the joint filler 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.

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 DELIVERY AND STORAGE

A. Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants.

PART 2 PRODUCTS

2.1 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.

PART 3

PART 3 EXECUTION

3.1 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.

- END OF SECTION -

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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 and Construction Joints
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
19. ASTM C 1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable)

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. Miscellaneous product information.

1. Catalog information and shop drawings for: admixtures, bonding agents, membrane curing compound, embedded items, non-shrink grout, wedge-type expansion anchors, and other concrete appurtenances.

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.

G. In case of a conflict between the referenced specifications or standards and this Specification, the one having the more stringent requirements, as determined by ENGINEER, shall govern.

H. 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

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.

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 INSPECTION

A. GENERAL

1. Assure that excavations and formwork are completed.
2. Assure that dirt, mud, encrusted concrete, debris and excess water have been removed.
3. Check that reinforcement is properly positioned and secured in place.
4. Verify that expansion joint material, anchors, and other embedded items are secured

in proper position.

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. If there are discrepancies between this Section and Section 01 45 00, the more stringent requirement shall apply.

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 slump test or 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

PART 1 GENERAL

1.1 REQUIREMENTS

A. CONTRACTOR shall provide Controlled Low Strength Material (CLSM), 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 grouts 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 30 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 30 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. 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.

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	Minimum Net Area[(1)] Compressive Strength (psi)
Concrete Masonry Unit (CMU)	C90	Medium Weight	Per Dwgs	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.

2.6 MASONRY SEALERS

A. Sealers shall be as noted in Section 09 90 00 - Painting and Finishes.

2.7 INSULATION

A. Refer to Section 07 21 00 for foamed-in-place CMU insulation.

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 per 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 Specialties
3. Section 09 90 00 Painting and Finishes
4. Section 33 05 05 Ductile Iron Pipe
5. Section 33 05 07.1 PVC Pressure Pipe (ASMT 1785)
6. Section 33 12 00 Mechanical Appurtenances
7. Section 40 05 13.33 Brass 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 Contract 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 Contract 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 Contract Drawings shall have a protective coating in accordance with the requirements of Section 09 90 00 – Painting and Finishes.

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 Specialties.

2.7 MANUFACTURERS

A. Mechanical Metal Support (pipe support) manufacturers shall be **Anvil (an ASC Engineered Solution), 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.

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 Contract Drawings. If no spacing or rod sizes are given on the Contract Drawings or in the Specifications for a particular piping system, use the following tables or the recommendations of the support or pipe manufacturer.

1. 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	30
10	30
12	35
14	35
16	40
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.	

2. Support spacing for other pipe materials shall be based on recommendations from the pipe manufacturer.
3. Provide sway bracing for hangers where shown on the Contract Drawings. If no bracing is shown, provide bracing at 10 foot maximum center-to-center intervals.

- END OF SECTION -

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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 WORK

A. Related Work 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

1.3 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.

1.4 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.

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

1.5 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, and other items required shall be stainless steel unless noted otherwise.

2.3 HOT-DIPPED GALVANIZED

A. All 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.

E. MJ T-bolts: See Section 33 05 05 Ductile Iron Pipe.

F. Flange Bolts: See Section 33 05 05 Ductile Iron Pipe.

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 HVA 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 3,** or approved equal. Anchors installed in non-submerged or non-corrosive environments may be carbon steel and be **Simpson Strong-Tie Strong Bolt**, 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 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.

2.11 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.

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 Contract 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.

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 sheathing for roof 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 Contract 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 and ceiling 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 -

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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 272 Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
2. ASTM C 518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
3. ASTM C 547 Standard Specification for Mineral Fiber Pipe Insulation
4. ASTM C 549 Standard Specification for Perlite Loose Fill Insulation
5. ASTM C 553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
6. ASTM C 578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
7. ASTM C 592 Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
8. ASTM C 612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
9. ASTM C 665 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
10. ASTM C 1029 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
11. ASTM D 1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
12. ASTM D 1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics
13. ASTM D 2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics
14. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

15. 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.

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 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.

2.3 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.

2.4 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.

2.5 CMU 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
Thermal 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.

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 -

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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 90 wind uplift rating, including relevant construction number. UL listed construction number shall be used by Special Inspector to confirm installation meets UL90 listing.

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 QUALITY ASSURANCE

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Store panels, flashings and accessories ion a safe, dry environment under a waterproof breathable covering to prevent water damage. Allow for adequate ventilation to prevent condensation. Panels and flashings with strippable film shall not be stored in direct sunlight.

D. Remove strippable protective covering on metal panels during installation.

E. Upon receipt of delivery of metal panel system, and prior to signing the delivery ticket, the installer is to examine each shipment for damage and for completion of the consignment.

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 **Elevate, 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.

I. Ice and Water Shield:

1. Ice and Water Shield shall be a minimum 40 mil, self-adhered roofing underlayment membrane composed of two waterproofing materials - an aggressive rubberized asphalt adhesive backed by a layer of slip resistant coated high density cross laminated polyethylene film. Shield shall meet the requirements of ICC AC-48 Install Ice and Water Shield per the manufacturer's printed installation instructions from edge of eaves to 24-inches past exterior wall. Ice and Water Shield underlayment shall be Grace Ice & Water Shield by Grace Construction Products, or approved equal.

2.3 ROOF RIDGE VENT

A. Provide and install a continuous vented roof ridge vent along the entire roof ridge. Roof ridge vent shall be the same material and color as the roof panels. The ridge vent shall be provided with a bug screen. Roof ridge shall be sized to provide a minimum of 765 square inches of ventilation area.

2.4 SOFFITS

A. Soffits shall be of the same make as the roof panel system. Soffits shall be sized to provide a minimum of 765 square inches of ventilation area.

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 and shall meet the requirements of UL Construction Number to meet UL90 rating.

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 -

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.

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. 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 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.

2.7 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:

1. Galvanized Steel: 0.028 inch thick.

2.8 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.

2.9 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 -

07SECTION 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

1.2 RELATED DOCUMENTS

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 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

1.4 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

F. USDA Approval: Provide documentation that the product is approved for use in meat and poultry processing areas by the USDA for the following types of sealants:

1. Polyurethane
2. Tape Mastic
3. Non-skinning Sealant

1.5 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.

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, FRAMES, AND HARDWARE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers all the work necessary to furnish and install the new acoustic 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 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.

PART 2 PRODUCTS

2.1 ACOUSTIC SOUND DOORS AND FRAMES

A. **General:** Sound retardant doors (acoustic sound 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. 509391**, or approved equal, with a STC rating of 50 when tested as an operable system in accordance with ASTM E90 and ASTM E413.

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 1008 (Replacement Standard for 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. **Removable Transom**: Removable transom shall be constructed from the same gauge steel as the door and shall be filled with same sound insulating material as the door.

F. **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.

G. **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.

H. **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.

I. **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.

J. **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.

K. **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.

L. **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 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. Cylinder Lock Set: **40H Series by Best Access Systems**.

D. Lever Extension Flush Bolt, Upper, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

E. Lever Extension Flush Bolt, Lower, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

F. Threshold: **#277AS by Pemko Corporation**, or approved equal, raised interior, extruded aluminum threshold with neoprene seal.

G. Drip Cap: Provide drip cap on all exterior doors. Drip cap shall be clear anodized aluminum, **Pemko 346C**, or approved equal.

H. Door Closers w/ Hold Open Arm: 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.

I. 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.

J. Door Stop: Solid cast brass, DuraFlex bumper, **Rockwood #445**, or approved equal (Inactive leaf only)

K. Non-Mortise Door Edge with Astragal: 0.06” thick stainless steel, **Rockwood HD306B-AST**, or approved equal (double doors only)

L. 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.

2.3 FINISH

A. Surfaces shall be provided with a shop-primed galvannealed 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.

2.4 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

Each to Receive:

Quantity	Item	Model No.	Finish	Manufacturer
3 each*	Hinge	MCL-500	STD	Overly
1 each*	Lockset	47H-7-AB-15-M-630-S6-VT	630	Best Access Systems
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	Closer	4040XP	689	LCN
1 each	Pull Plate	110 x 70C	630	Rockwood
1 each	Kickplate	K1050F	630	Rockwood
1 each	Threshold	277AS	Alum	Pemko
1 each	Drip Cap	346C	Alum	Pemko
1 set	Perimeter Seal	As Req’d	STD	Overly

*Five Knuckle, Stainless Steel, Non-removal Pin Hinges (size and quantity by door manufacturer)
** Deadbolt required on Active Leaf only
*** Inactive Leaf Only

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.

- END OF SECTION -`

SECTION 08 31 00
ACCESS HATCHES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers all the work necessary to furnish and install all hatches and appurtenances, complete and in place as shown 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 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 A 229 Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs
3. ASTM A 36 Standard Specification for Carbon Structural Steel
4. ASTM A 653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process

1.4 DESIGN REQUIREMENTS

A. Roof hatches for pump station shall be designed to handle a minimum live loading of 40 psf.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's catalog data and preprinted installation instructions for the hatches.

C. Submit a schedule showing the location of each hatch. Shop drawings shall include details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joining and connections.

1.6 DELIVERY AND STORAGE

A. Hatches shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon.

1.7 WARRANTY

A. Manufacturer shall provide to OWNER written guarantee against defects in material or workmanship for a period of five (5) years. Manufacturer must be able to have a representative on site within 48 hours to address any complaint or issues.

PART 2 PRODUCTS

2.1 HATCHES AND ACCESS DOORS

A. All hatches shall be provided with a permanent label showing the manufacturer's name and address and the model number.

B. Roof hatches shall be 12-inch in height and of 11-gauge aluminum. The curb shall be formed with a 3-1/2-inch flange with 7/16-inch holes provided for securing to the roof framing. The curb shall be equipped with an integral metal cap flashing of the same gauge and material as the curb, fully welded at the corners, and with stamped tabs, 6-inch on center, to be bent inward to hold single ply roofing membrane securely in place. Curbs shall have rigid, high-density fiberboard of 1-inch thickness on outside of curb. Roof hatches shall be capable of being opened from exterior or interior.

C. Hatch hardware, including the hinges, shall be fabricated from Type 316 stainless steel.

D. Hatches shall be provided with an automatic hold-open arm with release handle.

E. Hatches shall be designed to be watertight and equipped with an EPDM gasket.

F. Hatches shall be supplied with built-in, or CONTRACTOR installed position intrusion switches as specified on the Contract Drawings.

G. Manufacturer’s shall be **USF Fabrication, Inc., East Jordan Iron Works, Bilco Corp.**, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Hatches shall be installed in accordance with the approved detailed shop drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, hatches shall be weather tight and shall be free from warp, twist, or distortion. Hatches shall be lubricated, properly adjusted, and demonstrated to operate freely.

- 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.

B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

C. If the Work requires more than one overhead coiling door, a single manufacturer provide all the doors.

D. Products Requiring Electrical Connection: Listed and classified Underwriters Laboratories, Inc. (UL) acceptable to authority having jurisdiction as stable for purpose specified.

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 Specialties
3. Section 09 91 00 Painting and Finishes
4. Division 26

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 of 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.

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 20 psf.

C. Air infiltration shall comply with ASHRAE 90.1 requirements of less than 0.4 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 per ASCE 7-16.

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 1.00 CFM/SF, validated by an independent testing agency.

1. Fabrication:
   a. Slat Material: No. 6F or approximately 7/8-inch by 3-inch, (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: 7/8-inch foamed-in-place, polyurethane. Insulation shall be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.
   c. Total Slat Thickness: 15/16-inch
   d. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E 84.
   e. R-value: 8.0 (U-value of 0.125) per ASHRAE.
   f. STC Rating: Up to 30 for the curtain and up to 21 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. Coating System:

1) Galvanized Steel: ASTM A 653 galvanized base with rust-inhibitive, roll coating process, including thick baked-on prime paint.
2) Topcoat: Baked on premium powder coat, with color as selected by OWNER from manufacturer's standard color range.

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. Coating System:
    a. Galvanized Steel: ASTM A 653 galvanized base with rust-inhibitive, roll coating process, including thick baked-on prime paint.
    b. Topcoat: Baked on premium powder coat, with color as selected by OWNER from manufacturer's standard color range.

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.

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 **Schlage** or approved equal.

B. 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 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 in the Contract Drawings and in accordance with these 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.

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 – Assembly STC: (wood construction) 67

B. 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

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.
3. Cement Board Tape: Alkali-resistant fiberglass tape, 2-inch wide polymer-coated for interior applications and 4-inch wide polymer coated for exterior applications, **PermaBase Cement Board Tape**, **FibaTape Cement Board Tape**, **USG Durock Cement Board 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. 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.

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 the 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 on, 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 inches 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. Moisture and Mold Resistant Gypsum Board: Install at restrooms, kitchen, janitorial closets, and areas where moisture is present. Do not install as backer board for ceramic tile.

K. Ceramic Tile Backerboard: Install per manufacturer’s recommendations. Moisture resistant (green board) gypsum board not accepted as backer for ceramic tile.

L. Joint Sealant and Acoustical Sealant: Install to completely fill void between wallboard edges and adjacent surface.

M. Firestopping and Smoke Sealants: Install in accordance with manufacturer’s recommendations.

N. 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.

- END OF SECTION -

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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 Contract 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 03 30 00 Cast-in-Place Concrete
3. Section 05 50 00 Miscellaneous Specialties
4. Section 08 10 00 Doors, Frames, and Hardware
5. Section 33 05 05 Ductile Iron Pipe
6. Section 33 11 10 Miscellaneous Appurtenances
7. Section 33 92 10 Steel Pipe (AWWA C200)

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. Submit NSF 61 certification and batch number for verification of NSF 61 status.

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 Contract Drawings.

2.3 COATING SYSTEMS

A. System No. 1 Steel – Interior Pipe and Tank Lining (Drinking Water System)

1. Materials

Type	Epoxy conforming to AWWA C210
VOC content, max, g/L	311
Volume Solids, min, %	67
Demonstrated Suitable for	Long term immersion in water, resistant to corrosion, good color retention
Certification	NSF 61

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
SSPC-SP10 Near-White Blast Cleaning with minimum angular profile of 3.0 mils	Primer: Tnemec 22 Epoxoline (1218 Blue) Finish: Tnemec 22 Epoxoline (1218 Blue) NSF Notes: Max thinner: 5% Thinner #2, Recoat cure time 16 hrs @ 75-deg F, Final cure time 5 days @ 75-deg F, Mix ratio 1:1 (A:B by volume)	Primer: 12-15 DFT Finish: 12-15 DFT

3. Application
   a. For use on the interior of pump inlet piping, pump cans, steel blind flanges, and surge tanks for drinking water system.
   b. Application shall meet all NSF 61 certification requirements.
   c. Touch ups and field repairs shall be with System No. 16.
4. Special Requirement: Submit NSF 61 certification and batch number for verification of NSF 61 status.

B. System No. 2 Steel – Immersion Non-Potable Water (Pressurized Irrigation System)

1. Materials

Type	High Solids Polyamide Epoxy
VOC content, max, g/L	250
Volume Solids, min, %	67
Demonstrated Suitable for	Ferrous surfaces, superior color and gloss retention, exceptional resistance to weathering, chemical fumes, and salt spray

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
SSPC-SP10 Near-White Blast Cleaning with a minimum angular anchor profile of 1.5 mils	Primer: Tnemec Series L69 Hi-Build Epoxoline II (white) Intermediate: Tnemec Series L69 Hi-Build Epoxoline II (white) Finish: Tnemec Series L69 Hi-Build Epoxoline II (white)	Primer: 4 -6 DFT Intermediate: 4 -6 DFT Finish: 4 - 6 DFT

3. Application
   a. For use on the interior of pump inlet piping, pump cans, blind flanges, and surge tanks for pressurized irrigation system.
   b. Touch ups and field repairs shall be with System No. 16.

C. System No. 3 Steel – Interior Exposed (NOT USED)

D. System No. 4 Steel – Exterior Exposed (NOT USED)

E. System No. 5 Buried Steel Pipe & Pump Cans – Exterior Coating

1. Materials

Type	Polyurethane per AWWA C222
VOC content, max, g/L	No VOC content
Demonstrated Suitable for	Buried steel pipelines

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Abrasive Blast, or Centrifugal Wheel Blast SSPC-SP5	Futura Coatings - Protec II	35-50 mils DFT
	Tnemec Series 406 Elasto-Shield	
	Lifelast, Inc. – Durashield 210	
	Carboline Polyclad 777 PL or Polyclad 767	

3. Application
   a. Shop applied on all buried steel pipe and pump cans.
   b. Epoxy alternatives will not be considered.
   c. Field repairs and touch ups shall be as recommended by polyurethane supplier.

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

G. System No. 7 Ductile Iron Pipe and Fittings – Interior Lining (Non-buried)

1. Materials

Type	Two-component Ceramic Epoxy
Demonstrated Suitable for	Long term immersion in water, resistant to corrosion, good color retention
Certification	NSF 61

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
All oils, grease, and soluble deposits should be removed and uniformly abrasive blasted using angular abrasive in accordance with NAPF 500-03-04: Internal Pipe Surfaces. Any area where rust reappears before application shall be reblasted. The surface shall contain a minimum angular anchor profile of 3.0 mils (NACE RP0287 or ASTM D 4417, Method C).	Single Coat: Ceramapure PL90 (Gray)* NSF Notes: No thinner, Final cure time 30 days @ 75-deg F, Mix ratio 1:1 (A:B by volume), airless spray or plural component application	Singe Coat: 15-20 DFT
* Irrigation piping may be non-NSF certified but color selection shall be black if it is not certified.		

3. Application
   a. For use on the interior of all above grade pump station piping. System to be used for both drinking water and irrigation water piping.
   b. Application shall meet all NSF 61 certification requirements.
   c. Applicator shall be licensed by Induron for application of lining.
4. Special Requirement: Submit NSF 61 certification and batch number for verification of NSF 61 status as well as documentation showing certification to apply Ceramapure PL90.

H. System No. 8 Ductile Iron Pipe and Fittings – Exterior Coating (Non-buried)

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)
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
* Irrigation piping shall be painted Purple and drinking water piping shall be painted blue. Submit colors for approval.		

3. Application
   a. Exposed ductile iron pipe and fittings.
   b. Touch ups and field repairs shall be with System No. 16.

I. System No. 9 Concrete Floors – Light Traffic, Low Impact

1. Materials

Type	Modified Polyamine Epoxy
VOC content, max, g/L	75
Demonstrated Suitable for	Concrete floors providing protection against various acids and alkalis and frequent cleaning

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
SSPC-SP13 Concrete Surface Preparation, ICRI CSP 2-4	Primer: Tnemec Series 201 Epoxoprime Intermediate: Tnemec Series 281 Tneme-Glaze (w/ fine aggregate) Finish: Tnemec Series 281 Tneme-Glaze	Primer: 6-8 DFT Intermediate: 6-8 DFT Finish: 6-8 DFT

	Primer: Sherwin Williams Armorseal 33 Intermediate: Sherwin Williams 650 SL/RC (w/ fine aggregate) Finish: Sherwin Williams 650 SL/RC	
	Primer: Carboseal 720 Intermediate: Carboline Carboseal 745 (w/ fine aggregate) Finish: Carboline Carboseal 745	

3. Application
   a. Interior concrete floors.

J. System No. 10 Concrete Floors – Chemical Exposure (NOT USED)

K. System No. 11 – Gypsum Wallboard

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 on ceiling.

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. Ceiling trim and plywood sheathing.

P. System No. 16 – Epoxy Field Repairs and Touch Ups

1. Materials

Type	Epoxy conforming to AWWA C210
Volume Solids, min, %	100
Demonstrated Suitable for	Long term immersion in water, resistant to corrosion, good color retention
Certification	NSF 61

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
Existing painted surface shall be scarified prior to topcoating.	Tnemec Seres FC22 (B8869A Epoxoline Blue) NSF Notes: No thinner allowed, final cure time is 24 hours at 75-deg F, mix ratio 1:2 (A:B by volume)	20-30 DFT

3. Application
   a. For use on the interior and exterior of epoxy coated steel or ductile iron pipes and fittings.
   b. Application shall meet all NSF 61 certification requirements.
4. Special Requirement: Submit NSF 61 certification and batch number for verification of NSF 61 status.

2.4 SPECIAL COATING SYSTEMS

A. System 200 - PVC Tape (NOT USED)

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 and CMU walls of pump station.

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 –

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SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION

A. 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.

PART 2 PRODUCTS

2.1 GENERAL

A. 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-2: FE-2 fire extinguishers shall be 20 pound minimum capacity, A.B.C. dry-chemical type, with minimum UL rating of 20A:120BC.

B. Mounting brackets shall be specially designed for fire extinguisher.

C. Other materials not specifically shown on the Contract Drawings or listed in the specifications but required for a complete and proper installation shall be as selected by CONTRACTOR, subject to approval by 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. 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 33 12 00 Mechanical Appurtenances
5. Section 33 13 00 Pipeline Testing and Disinfection
6. Section 40 05 13.33 Brass Process Piping

1.3 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

1.4 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.

1.5 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.

1.6 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. Floor drain pipes 3” and less shall be PVC Sch40 DWV type and floor drains 4” and above shall be PVC Sch80 pipe.

B. Pipe couplings shall be flexible PVC type with stainless steel clamps and shall meet ASTM D5926 and C1173.

2.3 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.

2.4 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.

2.5 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.

2.6 UNIONS

A. Furnish and install unions for each valve or piece of equipment to permit easy installation and removal of equipment.

B. Gate and ball valves shall be in accordance with Section 33 12 00 – Mechanical Appurtenances.

2.7 TRENCH DRAINS IN CONCRETE FLOORS

A. Trench drains in concrete floors shall be polymer concrete with ductile iron edges and slotted ductile iron grates of the length indicated on the Contract Drawings and shall have built-in slopes of 0.5% minimum. Trench width shall be 8” minimum..

B. Trench drains shall be **S200K by ACO, Inc.,** or approved equal.

2.8 FLOOR DRAINS

A. 9-inch floor drains in concrete floors shall be constructed of cast iron with polished nickel bronze top of the size indicated on the Contract Drawings and provided with sediment buckets. Provide with 1/2-inch trap primer connection.

B. Floor drains shall be **ZN520-Y by Zurn Industries, 32100-AE-81 by Josam Company, Figure 2350 by Jay R Smith Mfg. Co**., or approved equal.

2.9 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.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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. 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.

C. Repair leaks in copper tubing by melting out joint, thoroughly cleaning both tubing and fitting, and resoldering.

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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 05 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 Lehi, 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 4500 feet above sea level. Make adjustment to manufacturer's performance data as needed.

Work includes:

- HVAC systems for the New Pump Station.

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:

A. 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.

B. 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.

C. 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.

1.9 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.

1.10 CHANGE ORDERS See General Conditions.

1.11 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.

1.12 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.

1.13 SUBMITTALS:

A. 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.

B. 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.

C. 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.

1.14 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).

1.15 GUARANTEE/WARRANTY:

A. 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."

B. 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.

C. 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.

D. 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.

1.16 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.

1.17 PERMITS, FEES, LICENSES: Refer to General Conditions.

1.18 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

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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 3 sets, 2 hardbound copies and 1 electronic copy of operation and maintenance (O&M) manuals within 90 days of system acceptance. Manuals shall contain descriptive drawings and data that 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 cataloged. 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).
3. Project Number (Per owner's project number).
4. Building name and number.
5. Owner's name.
6. (Architect's name.)
7. Engineer's name.
8. General Contractor's name.
9. 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.

3.4 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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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.
B. 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:

A. 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:

   a. 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.
   b. 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:

1. 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^{o}C environment with maximum 90^{o}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.

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SECTION 23 61 00
REFRIGERATION EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL MECHANICAL REQUIREMENTS:

A. All pertinent sections of Section 23 05 00 - General HVAC Requirements are a part of the work described in this section.

1.2 SUMMARY:

A. This section specifies:

1. Wall Mounted Air Conditioning Units

1.3 STANDARDS:

A. Uniform Building Code/International Mechanical Code

B. Local Codes and Ordinances

C. State Pressure Vessel Regulations

D. EPA Requirements.

E. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

F. ANSI/ASHRAE 90A - Energy Conservation in new Building Design.

G. ARI 370 - Sound Rating of Large Refrigeration and Air-conditioning Equipment.

H. ARI 360 - Unitary Air-Conditioning Equipment.

1.4 SHOP DRAWINGS/SUBMITTALS:

A. Submit a list of all materials to be used indicating brand or source, type and service.

B. Submit shop drawings for all equipment including shop drawing showing proposed sizes, capacities, accessories, manufacturer and model numbers, wiring diagrams, etc.

1.5 CONTRACTOR QUALIFICATION:

A. The Piping Contractor for this work shall be licensed as a firm in the Contractor state of origin and in the state where the work is performed.

B. The Subcontractor shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Subcontractor.

C. All workmen employed in the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.6 SCOPE OF THE WORK:

A. Furnish and install all refrigeration equipment and related work to effect a complete installation.

1. Provide and install Refrigeration Equipment as indicated on the drawings.
2. Other work indicated on the drawings.

1.7 INSTRUCTION OF OWNER'S PERSONNEL:

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.

1.8 WARRANTIES: See Section 23 05 00.

PART 2 – MATERIALS AND METHODS

2.1 WALL MOUNTED AIR CONDITIONING UNIT (WAC-1)

A. GENERAL: Provide self-contained, factory-assembled and tested, wall mounted, horizontal discharge supply and return, single-piece, 3 stage cooling unit with electric heat and full outside air economizer suitable for outdoor use. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.

B. PERFORMANCE:

1. See Equipment Schedule.

C. UNIT CABINET:

1. Unit cabinet shall be constructed of minimum 16 gauge zinc-coated galvanized steel, bonderize and coated with baked enamel or satin beige polyester finish on all externally exposed surfaces and interior panels which shall allow it to withstand a minimum of 1000 hours of salt spray exposure per ASTM B117-03.
2. The fan cabinet interior shall be insulated with a minimum 1/2-in thick, closed cell foam insulation with acrylic or neoprene coating on the air side.
3. The evaporator cooling section shall be insulated with a minimum 1/2-in thick, 2 lb. closed cell foam insulation with acrylic or neoprene coating on the air side.
4. Cabinet panels shall be easily removable for servicing.
5. Cabinet shall include a sloped top and built-in mounting flanges. Slots or holes shall be provided in the unit to facilitate transporting unit to location of installation.

6. Unit shall have a factory-installed, sloped stainless steel condensate drain pan, providing a minimum 3/4 in. connection with both vertical and horizontal drains and shall comply with ASHRAE 62.
7. Unit shall have factory-installed filter access panel to provide filter access with tool-less removal.
8. Unit shall have standard single point power connection point.

D. FANS:

1. Indoor blower (evaporator fans) shall be of the direct-driven, EC Motor Plenum fan. Impeller blades shall be made from aluminum with steel frame construction and shall be dynamically balanced.
2. Condenser fan shall be of the direct-driven propeller type and shall discharge air horizontally.

E. COMPRESSOR:

1. The compressors shall be scroll type with one 2-stage compressor and one single stage compressor.

F. COILS:

1. Evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes with all joints brazed. Coils shall be provided with a corrosive resistant coating.
2. Tube sheet openings shall be belled to prevent tube wear.
3. Evaporator coil shall be of the full-face active design.

G. REFRIGERANT COMPONENTS: Each of the two refrigerant circuits shall include:

1. Refrigerant strainer.
2. Sight Glass.
3. Expansion Valve.
4. Service gauge connections on suction, discharge, and liquid lines.
5. Suction and liquid access valves.
6. Filter drier.

H. FILTER SECTION:

1. Filter section shall consist of factory-installed low-velocity, throwaway, 2-in. thick, pleated filters of commercially available sizes (Farr 30-30 or equal).
2. Filter face velocity shall not exceed 300 fpm at nominal airflows.
3. Filters shall be accessible through an access panel with 'no-tool" removal.
4. Provide dirty filter indicator switch.

I. CONTROLS AND SAFETIES:

1. Unit Controls: Furnish unit with factory wired on-board PLC and a remote mounted PGDx touchscreen temperature and humidity controller. Furnish unit with the optional Free Cooling Economizer and all associated controls. Furnish unit with optional factory wired electric heat package and all associated controls.
2. Safeties:

    a. Unit shall incorporate a solid-state compressor protector which provides anti-cycle reset capability at the space temperature controller, should any of the following standard safety devices trip and shut off compressor.

        1) Compressor over temperature, over current.
        2) Loss-of-charge/low-pressure switch with automatic reset.
        3) Freeze-protection thermostat, evaporator coil.
        4) High-pressure switch. The lockout protection shall be easily disconnected at the control board, if necessary.

J. ELECTRICAL REQUIREMENTS:

1. All unit power wiring shall enter unit cabinet at a single factory-predrilled location. The air conditioner shall have a factory installed disconnect.

K. MOTORS:

1. Compressor motors shall be cooled by refrigerant passing through motor windings and shall have line break thermal and current overload protection.
2. Evaporative fan motor shall be electrically commutated with sealed, permanently lubricated, ball-bearings, temperature protection, soft start and an integrated PID controller. Maximum 1100 RPM.
3. Condenser-fan motor shall be totally enclosed, electrically commutated with sealed, permanently lubricated, ball-bearings, temperature protection, soft start and an integrated PID controller. Maximum 1100 RPM.

L. SPECIAL FEATURES:

1. Service: Air conditioning unit shall be equipped with hinged access panel for the filter, compressors(s), evaporator fan, and control box areas. Filter hinged access panels permit tool-less entry by removing and discarding screws. Each external hinged access panel shall be permanently attached to the air conditioning unit and equipped with a retainer for service convenience. The electrical control box, including the low voltage compartment, shall be accessible from the front of the air conditioner.
2. Fused disconnect switch: Provide fused disconnect switch factory-installed, internally-mounted. NEC and UL approved fused switch shall provide unit power shutoff. The control access door shall be interlocked with the fused disconnect. The disconnect switch must be in the OFF position to open the control box access door. Shall be accessible from outside the unit and shall provide power off lockout capability.

M. ACCEPTABLE MANUFACTURERS:

1. Subject to compliance with requirements, provide air conditioning unit from:

a. Bard MEGA-TEC
b. Engineer approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF WALL MOUNTED AIR CONDITIONING UNITS:

A. General: Install unit where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work, including wall construction, wall openings and electrical as necessary to interface installation of units with other work.

C. Access: Provide access space around units for service as indicated, but in no case less than that recommended by the manufacturer.

D. Support: Securely anchor units to the wall.

E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

F. Duct Connections: Provide ductwork sleeves connecting to unit supply and return air openings as indicated on the drawings in preparation for insertion of unit supply air diffuser and return air grille.

3.2 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.

B. Sheet Metal: Fabricate ductwork sleeves from galvanized steel, in gauges corresponding to the SMACNA recommendations.

C. Provide galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 120 zinc coating in accordance with ASTM A 525.

D. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.

E. Ducts at Structural and Architectural Penetrations: Where ducts are shown connecting to masonry openings, 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. Close openings between duct and structure.

F. Grounding: Provide positive equipment ground for wall mounted air conditioning unit components.

END OF SECTION

SECTION 26 05 00
ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 SCOPE

A. This Section consists of the Electrical General Requirements and related items necessary to provide complete and operational electrical system(s) indicated within the Contract Documents.

1.2 APPLICABLE SECTIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings, and the technical specifications herein shall apply to all work specified herein.

B. The CONTRACTOR shall comply with the specifications and accompanying drawings which describe and provide for the furnishing, delivering, installing, testing, and placing in satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete electrical system for power distribution, control, lighting, and auxiliary systems.

C. State Licensed Contractor - All contractors must have a current state contracting license. The CONTRACTOR shall be licensed as such in the CONTRACTOR state of origin and in the state where the work is performed.

D. The electrical contractor shall have a licensed Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed journeyman electrician shall be assigned to supervise the actual performance of all electrical work specified herein.

E. The licensed journeyman assigned to supervise the performance of all electrical work, shall be required to be on the job site at all times, while electrical work is being performed.

1.3 CONTRACT DOCUMENTS

A. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. Each is complementary 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 is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

B. The drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail, but shall be followed as closely as actual construction and work of other contractors will permit.

C. Data given herein and on drawings are as exact as could be secured, but their extreme accuracy is not guaranteed. Drawings and specifications are for the assistance and guidance of the CONTRACTOR; but exact locations, distances, and levels will be governed by actual conditions, and the CONTRACTOR is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the ENGINEER before commencing with the work.

D. The CONTRACTOR shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost. Raceway and conductors to panels from devices referred to as "home runs" are indicated by pointing in the general direction of panels. Construction shall continue such circuits to the panels as though the routes were completely indicated. Home runs shall be installed from devices to panels as indicated.

E. Deviations from the drawings required to make work of this contract conform to actual conditions as constructed, or as to work of other contractors, shall be made by the CONTRACTOR at his expense. The ENGINEER reserves the right to make minor changes in the location of equipment and devices without additional charges.

F. The CONTRACTOR shall familiarize himself with the architectural, structural, and civil/mechanical drawings and shall study drawings and details so that equipment will be properly located and readily accessible. If any conflicts occur necessitating departures from the contract drawings, details of departures and reasons therefore shall be submitted for prior approval.

G. In any case and at any time, a change in material or location is made necessary by CONTRACTOR's failure to take into account obstacles or the installation of other trades shown, whether on electrical drawings or other drawings, in existence at the time bids were received, such changes shall be made without charge to OWNER.

H. Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by the CONTRACTOR, Shop Drawings of various contractors shall be coordinated to take into account all obstacles that will interfere with the installation.

I. Every attempt has been made to indicate the installation and wiring requirements for all equipment to be installed. However, it shall be the CONTRACTOR’s responsibility to coordinate with equipment shop drawings and make adjustments necessary including; power and control wiring sizes and counts, breaker sizes, rough-in locations, etc. for actual equipment provided. The contractor shall provide in his bid the conductors and conduits required for the equipment to be installed. The contractor shall reference the mechanical drawings, the P&ID drawings, the control diagrams, the control drawings, the power drawings, the one line diagrams and all schedules. The contractor shall at his expense provide the conduit and conductors for the equipment installation for a complete and functional system.

J. Every attempt has been made in the drawings to indicate the general installation requirements for the power and control connections for the equipment indicated. However, equipment requirements vary from manufacturer to manufacturer and from date to date for equipment. The responsibility to coordinate the exact requirements of all equipment and install the required systems for these systems shall belong to the contractor, at his expense. No additional costs to the owner shall be incurred for the contractor's failure to coordinate these equipment requirements at the time of bid.

K. Electrical drawings are diagrammatic in nature and are not intended to show shop drawing style connections, equipment installation coordination or exact conduit and conductor sizes or counts. The contractor shall at his expense coordinate and provide necessary electrical and control components for a complete and functional system. If any conduit, equipment schedule, sizing, capacities, counts, lengths are unclear at the time of bidding or if conflicts exist on the drawings or in the specifications, the owner reserves the right for the installation of the more expensive or the more involved at no additional cost to the owner.

1.4 INFORMATION FOR ENGINEER

A. Submit the required information in accordance with the General Conditions, Section 00 70 00, and the following requirements.

1. The CONTRACTOR shall check all shop drawings for conformance with Contract Documents before submitting. The CONTRACTOR shall note on shop drawings any changes from items specified listing reasons and giving source of change such as "Approved Equal", "Addendum", or "Change Order". The CONTRACTOR shall be responsible for conformance with drawings and specifications; for dimensions to be confirmed and correlated at the job site: for information that pertains solely to the fabrication processes or the techniques for construction; and coordination of the work with other trades. Receipt or approval of shop drawings by the ENGINEER does not relieve the CONTRACTOR of the responsibility of complying with Contract Documents.
2. All shop drawings (drawings and manufacturer's data) required under each section of this Division 26 shall be submitted at the same time and be bound together in one hard back, three ring binders per copy, properly indexed for the formal submittal. Binder shall be sized to adequately contain all the materials therein and shall be labeled as to the identity of the job and the sub-contractor.
3. Shop drawings shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, wiring or schematic diagrams, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.

B. Material Lists: Include manufacturer, type and model number of equipment that will be provided as called for under each section of this Division 26.

C. Other Information: As required by the ENGINEER.

1.5 CODES, LICENSES AND STANDARDS

A. Perform work in accordance with best present-day installation and manufacturing practices. Comply with all applicable laws, building and construction codes, and requirements of governmental agencies under whose jurisdiction work is being performed. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of the following codes and standards.

1. American Society for Testing and Materials (ASTM)

2. National Fire Protection Association (NFPA)

3. National Electrical Code (NFPA 70-NEC)

4. Insulated Power Cable Engineers Association (ICEA)

5. Underwriters Laboratories Inc. (UL)

6. American Steel and Iron Institute, "Design Manual on Steel Electrical Raceways"

7. National Electrical Manufacturer's Association (NEMA)

8. National Electrical Contractor’s Association (NECA)

9. American National Standards Institute (ANSI)

10. International Building Code (IBC)

11. State of Nevada Electrical, Energy, Building and Safety Codes

12. Institute of Electrical and Electronic Engineers (IEEE)

13. Instrument Society of America

14. Wastewater Treatment Plants (NFPA-820)

15. US Environmental Protection Agency (EPA)

B. Conflicts Between Above Codes and Standards: The code or standard establishing the more stringent requirements shall be followed.

C. Conflicts Between Codes and Standards and Specifications and/or Drawings:

The one establishing the more stringent requirements shall be followed.

1.6 MATERIALS AND WORKMANSHIP

A. Each type of equipment or material shall be the same make and quality. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer as approved by the ENGINEER to conform to the Contract Documents.

B. The installation shall be accomplished by workmen skilled in the type of work involved.

C. All materials and equipment furnished and installed shall be of best quality, new, free from defects and meet the standards of NEMA, ICEA, UL, NFPA, IBC, OSHA, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer's name, the type and quality required is thereby denoted. The ENGINEER shall be afforded every facility, deemed necessary to observe and examine the materials and apparatus being installed to prove their quality.

D. Workmanship shall be the best quality of its kind for the respective industry crafts and practices, be neat and orderly throughout the project and shall be acceptable in every respect to the ENGINEER. Nothing contained herein shall relieve the CONTRACTOR from making good and perfect work in all details of construction.

E. The CONTRACTOR shall work in harmony with the ENGINEER and with other contractor's, companies or individuals working in connection with this project. Imperfections or discrepancies by other contractors shall not relieve responsibility of this CONTRACTOR. Store materials orderly and clean up without interference with other trades.

1.7 DEFECTIVE EQUIPMENT

A. If equipment fails to conform to detailed specifications or to operate satisfactorily, the OWNER will have the right to operate equipment until defects are corrected.

1. The OWNER will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear.

2. Remove equipment from operation for examination, adjustment, alteration or change only at times approved by the OWNER.

1.8 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work under way, and apparatus against loss or damage.

B. Materials and apparatus shall be stored with environmental protection and other necessary conditions as recommend or required by the manufacturers'.

1.9 RECORD DRAWINGS

A. The Contract Document drawings will be used by the CONTRACTOR who shall accurately and neatly mark in colored pencil all changes or deviations from the drawings as they are made in the work.

B. Refer to Section 01 70 00 Contract Closeout for additional requirements.

1.10 COORDINATION OF CONSTRUCTION

A. Coordinate work with other contractors, the OWNER, and the ENGINEER to assure orderly and expeditious progress of work. Select order of work and establish schedule of working hours for construction. This is subject to review by the OWNER if the work involved is part of a functioning facility. If such is the case, the CONTRACTOR shall carefully coordinate any disruption of service with the OWNER. Any after hours/weekend outages shall be accommodated at no additional cost to the OWNER.

B. The electrical work shall be laid out in advance of construction to eliminate unnecessary cutting, drilling, or channeling, etc. Where such cutting and drilling, or channeling becomes necessary for proper installation; perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the OWNER. Cutting work of other trades shall be done only with the consent of the CONTRACTOR. Cutting of structural members shall be done only with the written approval of the ENGINEER.

C. Comply with the following:

1. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

2. Install electrical equipment to facilitate servicing, 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.

3. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

D. Cooperate with other trades to coordinate locations of electrical devices and apparatus.

E. Perform for other trades the electrical wiring and connections, for all devices or apparatus where not specified herein or indicated on the drawings. Consult the architectural and mechanical drawings to avoid the location of switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc. Hidden electrical devices and/or connections shall be relocated as directed, at no additional cost to the OWNER.

F. Where conduit, outlets or apparatus is to be cast in concrete or encased, it must be located and secured by a journeyman or foreman present at the point of installation. He shall check the locations of the electrical items before and after the concrete and masonry installation and shall relocate displaced items at no additional cost.

1.11 USE OF SUBSTITUTES

A. Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the specifications to exclude other equipment or materials that equal or exceed the standard of those specified. If the CONTRACTOR desires to use substitute equipment or materials, he must submit for written approval as outlined in the General Conditions of the Contract Documents.

1.12 SITE CONDITIONS

A. Examination of Site: Examination of the site shall be made by the CONTRACTOR, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. He shall, at such time, ascertain and check all conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expenses to which he may be put due to failure or neglect on his part to make such examination.

B. Review of Plans: Review all work indicated on drawings and specified herein with proper authorities responsible for interpreting applicable codes, ENGINEER, and local inspector prior to commencement with construction as listed herein, but not necessarily limited thereto:

1. Visit site prior to executing bid.

2. Verify measurements and locations of field measurements of existing conditions and those developed by construction.

3. Confirm requirements of work at off-site, publicly owned property with local authorities

4. Confirm connection requirements, sizes and layout with local public utilities.

5. Conditions discovered in conflict with intent of drawings and/or specifications must be clarified with ENGINEER prior to execution of work.

1.13 CLEAN-UP

A. As the work progresses and on a daily basis, the CONTRACTOR shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from his operations and shall leave all equipment and material furnished by him absolutely clean and ready for use.

1.14 SUPERVISION:

A. A competent foreman or superintendent initially approved by the ENGINEER shall be at the site at all times to receive instructions and shall be empowered to act. He shall verify dimensions given on the drawings and report any discrepancies or inconsistencies to the ENGINEER before commencing the work. The ENGINEER, or his representative, will interpret the meaning of the drawings and specifications where questions arise.

1.15 SAFETY REGULATIONS

A. The CONTRACTOR shall comply with OSHA and all other safety codes required by law and shall furnish and place proper protection for prevention of accidents. He/she shall provide and maintain any necessary construction required to secure safety of life or property during the performance of his/her work, including the maintenance of sufficient lights to secure such protection.

1.16 DISPOSITION OF EXISTING EQUIPMENT REMOVED FROM SERVICE

A. Existing equipment and materials such as cables, switches, conductors, etc., which are removed and not reused in the new installation shall remain the property of the OWNER. The CONTRACTOR shall deliver such equipment to storage place as directed. Items not wanted by the OWNER shall be removed from the site and disposed of by the CONTRACTOR.

1.17 PERMITS AND FEES

A. Obtain all permits and pay all fees for inspections, required by code for all the work covered under Division 26 of the specifications. All fees shall be included in the contract price. The CONTRACTOR shall furnish a certificate of approval to the ENGINEER from each inspection authority at completion of the work.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 FIELD DESIGN CHANGES

A. No field changes, additions, or change in locations shall be made without written approval from the ENGINEER.

3.2 EXCAVATION AND BACKFILLING

A. The CONTRACTOR shall perform all excavation, trenching and backfilling work, and remove all debris in connection with his work. Backfilling shall be done with materials acceptable to the ENGINEER and thoroughly tamped in place. All disturbed surfaces shall be restored to their original condition and properly installed to eliminate any settlement. Inside and outside, backfill shall be in 6-inch layers, compacted to 95% of the "standard protector test".

B. Perform excavation in a manner to protect walls, footings and other structural members, from being disturbed or damaged in any way.

3.3 ROUGH-IN REQUIREMENTS

A. Architectural, structural and mechanical drawings shall be continually consulted and referred to. Exact placement of sleeves, conduit, and equipment shall be provided for by checking building and equipment dimensions. Equipment requirements and dimensions related there to shall be determined from detailed rough-in dimensions of each piece of equipment shown on Shop Drawings furnished by manufacturer.

3.4 CUTTING AND PATCHING CHASES AND OPENINGS

A. Provide for all required cutting and patching, anchors, openings, slots, chases, etc., in construction for electrical work. Cutting and patching performed under direction of CONTRACTOR and will leave no discernable scars.

B. The CONTRACTOR shall be responsible for block-outs or demolition work pertaining to the installation of the electrical system.

C. In Remodeling and/or Addition projects, all salvageable electrical equipment and materials that cannot be integrated into the new electrical network becomes the property of the OWNER. Remove from the premises materials which the OWNER decides not to keep, as directed by the ENGINEER.

3.5 WORKMANSHIP

A. The CONTRACTOR shall be held solely responsible for the proper installation of his work. He shall arrange with the proper contractors for the building in of anchors, etc., and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by his failure or neglect to make such arrangements with others. Any cutting or patching done by this CONTRACTOR shall be subject to the directions of the ENGINEER and shall not be started until approval has been obtained.

B. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the CONTRACTOR shall secure the approval of the ENGINEER.

C. This CONTRACTOR shall assign persons in direct charge of work who are thoroughly experienced in the class of construction work specified herein. All labor shall be performed in a workman like manner by skilled workmen under the supervision of competent foremen.

D. This CONTRACTOR shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, he shall remove all his rubbish, tools, scaffolds and surplus materials from and about the site, leaving his work clean and the areas ready for occupancy.

3.6 SEISMIC RESTRAINT

A. The International Building Code requires that not only the structure, but also major mechanical and electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and SMACNA "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.

3.7 TESTS

A. On completion of the work, the installation shall be tested free from all grounds and short circuits.

B. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The CONTRACTOR shall submit a written report to the ENGINEER showing methods and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

C. Submit a record of voltage readings and amp meter readings on all feeders, motor full load amps, outside lighting, and service conductors to the facility. If there are any abnormal conditions, they shall be brought to the attention of the ENGINEER in writing as a part of this submittal.

D. Refer to Section 26 05 08 Electrical Acceptance Tests for additional requirements.

3.8 SUBSTANTIAL AND FINAL COMPLETION

A. Notify the ENGINEER when work is considered to be complete, in operating condition, and ready for Substantial Completion.

B. The ENGINEER, after determining that installation is ready for Substantial Completion, will make walkthrough and perform operational tests deemed necessary to determine that provisions of specifications are satisfied and prepare a list of outstanding items.

C. The OWNER will not accept work nor make final payment to CONTRACTOR until ENGINEER has certified that work of CONTRACTOR is complete and in conformance with specifications and guarantees.

D. Leave the job in complete order ready for use. All fixtures and equipment shall be tight, fully equipped and completely cleaned. All equipment shall have been operated, checked and approved by the OWNER before the project can be accepted.

E. At the time of the substantial and final walkthroughs, the project foreman shall accompany the party and remove cover plates, panel and enclosure covers, and other access panels for the ENGINEER, to allow complete observation of the entire electrical system(s).

F. Notify the ENGINEER when work is considered to be complete, including list of outstanding items, and is ready for Final Completion. Refer to Section 01 70 00 Contract Closeout for additional requirements.

3.9 TRAINING

A. Instruct OWNER's operating personnel in proper operation of the complete electrical system including all electrical equipment, switching, disconnects, panels, controls, etc., during a scheduled training tour for the OWNER’s personnel of entire project after Substantial Completion and prior to Final Completion. Confirm complete understanding on part of OWNER's operating personnel. Utilize the Operations and Maintenance Manuals specified elsewhere during the instruction process.

3.10 GUARANTEE/WARRANTY

A. The following guarantee is a part of the specification and shall be binding on the part of the CONTRACTOR and shall be submitted by letter to the OWNER prior to acceptance.

B. The CONTRACTOR guarantees that this installation complies with the drawings and specifications in all respects, and is free from defects. He agrees to replace or repair, to the satisfaction of the ENGINEER, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after Final Completion.

C. The CONTRACTOR guarantees that the installation of OWNER furnished equipment is free from defects. He agrees to provide labor to repair or replace to the satisfaction of the ENGINEER any part of his installation of the OWNER furnished equipment (the respective equipment vendor will provide all parts and labor for the equipment), which may fail or be determined to be unacceptable within a period of one (1) year after Final Completion.

D. Electrical and instrumentation systems and equipment shall not be considered acceptable for Substantial Completion until they have performed in service continuously without malfunction for at least ten (10) days.

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

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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 Horrocks Corporation – Nothwest Quadrant Facility personnel 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.
o. Typical time separations for curves:

    1) Contractor shall discuss the advantages and disadvantages of various time separation settings between device curves with Horrocks Corporation – Northwest Quadrant Facility personnel to help determine how the system settings shall be optimized for selectivity and arc flash hazard reduction.

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.

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SECTION 26 05 08
ELECTRICAL ACCEPTANCE TEST

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to provide the inspection and testing services required to place the electrical system into operation.

1.2 GENERAL

A. This work may be conducted by the electrical subcontractors and/or independent testing laboratory but shall be performed by qualified personnel. The term "testing laboratory" shall unilaterally refer to the firm, subcontractor, etc., approved to conduct the tests.
   1. For the purposes of the section the individual performing the testing, whether the electrical subcontractor, manufacturer's representatives or independent testing laboratory, shall be referred to as "testing laboratory."
   2. The Contractor shall submit a division of responsibilities that shall detail who is responsible for performing each test.
   3. All visual and mechanical inspections shall be conducted by the Contractor and Engineer.

B. The testing laboratory shall provide all material, equipment power, labor and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all electrical equipment is operational within industry and manufacturer's tolerances.

D. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the service company responsible.

E. The tests and inspections shall determine suitability for continued reliable operation.

F. All tests shall be conducted in the presence of the Engineer.

G. Electrical testing specified herein, and functional testing of all power and controls not tested under the Section 40 10 00 Process Control and Instrumentation Systems, shall be completed before commencement of the 7-day test specified in Section 26 05 08, Electrical Acceptance Tests.

H. The work may require the Contractor to activate circuits, shutdown circuits and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.

I. Specific scope of work:
   1. The following items of equipment shall be tested:
      a. Low voltage switchgear
      b. Motor control centers
      c. Transformers
      d. All wires and cables

e. Motors

f. Grounding system

g. Entire control system and all process interfaces

h. Adjustable speed drive (ASD) systems

i. Switches

j. Lighting

2. All inspections and tests shall utilize the following references:

a. Project design specifications

b. Project design drawings

c. Manufacturer's instruction manuals applicable to each particular apparatus.

J. Division of responsibility:

1. The Contractor shall perform routing insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior and in addition to tests performed by the testing laboratory specified herein.

2. The Contractor shall supply a suitable and stable source of test power to the test laboratory at each test site. The testing laboratory shall specify requirements.

3. The Contractor shall notify the testing laboratory and schedule with the Engineer when equipment becomes available for acceptance tests.

4. The Contractor shall notify the Engineer prior to commencement of any testing.

5. The testing laboratory shall be responsible for implementing all final settings and adjustments on protective devices and tap changes in accordance with Owner's specified values.

6. Any system material or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the Engineer.

7. The testing laboratory shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

1.3 REFERENCED STANDARDS

A. See Section 26 05 00, General Electrical Requirements, which lists the standards that apply to the work specified herein.

B. In addition, the following shall apply:

1. Manufacturer's recommended tests

2. ANSI C2, C37.20.1

3. NEMA WC 7, WC 8

4. IEEE 43,48,81,118

5. NETA ATS

6. NFPA 70

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Division 1, GENERAL REQUIREMENTS and Section 26 05 00, General Electrical Requirements.

B. In addition, the following information shall be provided:

1. Shop drawings:

a. The testing laboratory shall submit a complete resume and statement of qualifications detailing their experiences in performing the test specified. This statement shall include:

1) Corporate history and references.

2) Resume of individual performing test.

3) Equipment list and test calibration data.

b. The Contractor shall submit to the Engineer and the testing laboratory, Contractor Submittals, complete manufacturer's field testing acceptance testing procedures, as well as expected test results and tolerances for all equipment to be tested.

1) Administrative Submittals: Submit 30 days prior to performing inspection or tests:

2) Schedule for performing inspection and tests.

3) List of references to be used for each test.

4) Sample copy of equipment and materials inspection form(s).

5) Sample copy of individual device test form.

6) Sample copy of individual system test form.

7) Quality Control Submittals: Submit within 15 days after completion of test: Test or inspection reports and certificates for each electrical item tested.

8) Contract Closeout Submittals:

a) Operation and Maintenance Data:

b) In accordance with Section 26 05 00, Operation and Maintenance Data

c) After test or inspection reports have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

2. Test Report:

a. The test report shall include the following:

1) Summary of project.

2) Description of equipment tested.

3) Description of test.

4) Test results.

5) Conclusions and recommendations.

6) Appendix, including appropriate test forms.

7) List of test equipment used and calibration date.

b. Furnish six (6) copies of the completed report to the Engineer.

PART 2 - PRODUCTS

2.1 TEST INSTRUMENT TRACEABILITY

A. The testing laboratory shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

B. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

C. Instruments shall be calibrated in accordance with the following frequency schedule.
   1. Field instruments - 6 months maximum.
   2. Laboratory instruments - 12 months.
   3. Leased specialty equipment - 12 months. (Where accuracy is guaranteed by lessor).

D. Dated calibration labels shall be visible on all test equipment.

E. Records must be kept up-to-date which show date and results of all instruments calibrated or tested.

F. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

PART 3 - EXECUTION

3.1 SAFETY

A. Safety and Precautions:

1. Safety practices shall include, but are not limited to the following requirements:
   a. Occupational Safety and Health Act - OSHA
   b. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.
   c. Applicable State and Local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. National Fire Protection Association - NFPA 70E.
2. The testing laboratory shall be solely responsible for safety during all tests.
3. In all cases, work shall not proceed until the testing laboratory, Contractor, and Engineer determine that it is safe to do so.
4. The testing laboratory shall have available sufficient protective barriers and warning signs to conduct specified tests safety.

B. Testing requirements prior to commencing the work:

1. All instruments required must be available and in proper operating conditions.
2. All dispensable materials such as solvents, rags and brushes required must be

provided.

3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment must be available or scheduled.
4. All instruction books, calibration curves or other printed material to cover the electrical devices must be available.
5. Data sheets to record all test results must be available before the work is started.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable to be energized.
4. Installation conforms to requirements of these specifications and NFPA 70, NFPA 70E, and ANSI C2.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust all mechanisms and moving parts for free mechanical movement.

F. Adjust all adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance with these specifications.

H. Realign equipment not properly aligned and correct any unevenness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten all accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of all applicable moving parts.

M. Inform Engineer of any working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by the Engineer, door and/or panel sections having dented surfaces.

5. Repair or replace, as determined by the Engineer, poor-fitting doors and/or panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch-up scratches and mars.
    b. If required due to extensive damage, as determined by the Engineer, refinish the entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by these specifications.

Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.2 QUALITY ASSURANCE

A. Testing Firm's Qualifications:

1. Corporately and financially independent organization which can function as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologies (NICET), or International electrical Testing Association and having a minimum of five (5) years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two (2) certified to one (1) noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA 29 CFR Part 1907, "Criteria for Accreditation of Testing Laboratories," or a full-member company of the International Electrical Testing Association.
9. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

3.3 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with Engineer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Engineer at least 24 hours prior to performing any tests on energized electrical equipment.

3.4 INSPECTION AND TEST PROCEDURES

A. Switchgear Assembly:

1. Visual and mechanical inspection for:
   a. Physical damage
   b. Equipment nameplate information conformance with latest single line diagram and report discrepancies.
   c. Proper alignment, anchorage and grounding.
   d. Tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instruction for proper foot pound levels.
   e. Paint chips, dents, scratches, etc.
   f. Insulator damage and contaminated surfaces.
   g. Proper barrier and shutter installation and operation.
   h. Proper operation of indicating devices.
   i. Improper blockage of air cooling passages.
   j. Integrity and contamination of bus insulation system.
   k. Check nameplates for proper identification of:
      1) Equipment title and tag number with latest one-line diagram.
      2) Pushbuttons.
      3) Control switches.
      4) Pilot lights.
      5) Control relays.
      6) Circuit breakers.
      7) Indicating meters.
   l. Verify that fuse and/or circuit breaker ratings, sizes, and types conform to those specified.
   m. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
      1) Ohmic value to be zero.
      2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
   n. Check operation and sequencing of electrical and mechanical interlock systems by:

1) Closure attempt for locked open devices.

2) Opening attempt for locked closed devices.

3) Key exchange to operate devices in off-normal positions.

o. Verify performance of each control device and feature.

p. Control wiring:

1) Compare wiring to local and remote control and protective devices with elementary diagrams.

2) Proper conductor lacing and bundling.

3) Proper conductor identification.

4) Proper conductor logs and connections.

q. Exercise all active components.

r. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

2. Electrical tests:

a. Insulation resistance test:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7. 1. 1.

2) Each phase of each bus section.

3) Phase-to-phase and phase-to-ground for I minute.

4) With switches and breakers open.

5) With switches and breakers closed.

6) Control wiring except that connected to solid state components.

7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

b. Overpotential test:

1) Applied voltage and test procedure in accordance with ANSIC37.20.1.

2) Each phase of each bus section.

3) Phase-to-phase and phase-to-ground for I minute.

4) Test results evaluated on a pass-fail basis.

c. Current injection tests:

1) For entire current circuit in each section.

2) Secondary injection for current flow of I ampere.

3) Test current at each device.

d. Control wiring:

1) Apply secondary voltage to all control power and potential circuits.

2) Check voltage levels at each point on terminal boards and each device terminal.

e. Operational test:

1) Initiate all control devices.

2) Check proper operation of control system in each section.

3. Test values:

a. Bolt torque levels shall be in accordance with values specified by manufacturer.

b. Insulation resistance test to be performed in accordance with manufacturer's specified values.

B. Grounding Systems:

1. Visual and mechanical inspection for:

a. Compliance with plans and specifications.

b. Equipment and circuit grounds in motor control centers, panelboards, switchgear, and motors for proper connection and tightness.

c. Ground bus connections in motor control centers, panelboards, switchgear, and control panels for proper termination and tightness.

d. Effective transformer core and equipment grounding.

e. Accessible connections to grounding electrodes for proper fit and tightness.

Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

2. Electrical tests:

a. Perform fall of potential test per IEEE Standard No. 81, Section 9.04 on the main grounding electrode or system.

b. Perform the two (2) point method test per IEEE No. 8 1, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points. Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohms.

c. Alternate method: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point. This test shall be made by passing a minimum of test (IO) amperes D.C. current between ground reference system and the ground point to be tested. Voltage drop shall be measured and resistance calculated by voltage drop method.

3. Test values: The main ground electrode system resistance to ground should be no greater than one (1) ohm.

C. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:

a. Physical damage and proper connection in accordance with single line diagram.

b. Equipment nameplate data compliance with design plans or starter schedule.

c. Overload heaters compliance with motor full load current for proper size.

d. Tightness of bolted connections.

e. Proper barrier and shutter installation and operation.

f. Proper operation of indicating and monitoring devices.

g. Proper overload protection for each motor.

h. Improper blockage of air cooling passages.

i. Proper operation of any draw out elements.

j. Integrity and contamination of bus insulation system.

k. Check door and device interlocking system by:

    1) Closure attempt of device when door is in OPEN position.

    2) Opening attempt of door when device is in ON or CLOSED position.

l. Check nameplates for proper identification of:

    1) Equipment title and tag number with latest one-line diagram.

    2) Pushbuttons.

    3) Control switches.

    4) Pilot lights.

    5) Control relays.

    6) Circuit breakers.

    7) Indicating meters.

m. Verify that fuse and/or circuit breaker sizes and types conform to these specifications.

n. Verify that current and potential transformer ratios conform to these specifications.

o. Check bus connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.

    1) Ohmic value to be zero.

    2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

p. Check operation and sequencing of electrical and mechanical interlock systems by:

    1) Closure attempt for locked open devices.

    2) Opening attempt for locked open devices.

3) Key exchange to operate devices in off-normal positions.

q. Verify performance of each control device and feature furnished as part of the motor control center.

r. Control wiring:

1) Compare wiring to local and remote control, and protective devices with elementary diagrams.

2) Check for proper conductor lacing and bundling.

3) Check for proper conductor identification.

4) Check for proper conductor lugs and connections.

s. Exercise all active components.

t. Inspect contactors for:

1) Correct mechanical operations.

2) Correct contact gap, wipe, alignment, and pressure.

3) Correct torque of all connections.

u. Compare overload heater rating with full-load current for proper size.

v. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper

w. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

x. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.

y. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

z. Color coding conformance with specifications.

aa. Proper circuit identification.

bb. Proper lug type for conductor material.

cc. Proper lug installation.

dd. Proper shield grounding on shielded instrumentation cable.

ee. Proper terminations.

ff. Proper circuit identification.

gg. Proper termination of neutrals and grounds for correct operation of protective devices.

2. Electrical tests:

a. Insulation resistance tests:

1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.

2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.

3) Evaluate ohmic values by comparison with conductors of same length and type.

4) Investigate any values less than 50 megohms.

5) Measure insulation resistance of each control circuit with respect to ground.

6) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.

7) Bus section phase-to-phase and phase-to-ground for I minute on each phase.

8) Contactor phase-to-ground and across open contacts for I minute on each phase.

9) Starter section phase-to-phase and phase-to-ground on each phase with starter with starter contacts closed and protective devices open.

10) Test values to comply with NETA ATS, Table 10.2.

b. Overpotential tests:

1) Maximum applied voltage in accordance with NETA ATS, Table 7.1.2.

2) Phase-to-phase and phase-to-ground for I minute for each phase of each bus section.

3) Test results evaluated on pass/fail basis.

c. Current injection through overload unit at 300 percent of motor full-load current and monitor trip time:

1) Trip time in accordance with manufacturer's published data.

2) Investigate values in excess of 120 seconds.

d. Control wiring tests:

1) Apply secondary voltage to all control power and potential circuits.

2) Check voltage levels at each point on terminal boards and each device terminal.

3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components.

4) Insulation resistance to be I megohm minimum.

3. Test values:

a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.

b. Bolt torque levels shall be in accordance with manufacturer's specifications unless otherwise specified by manufacturer.

c. Control wiring insulation test voltage shall be 500 V D.C. Manufacturer shall be consulted for test voltage where solid state control devices are utilized.

d. Overload tests shall be made at three hundred percent (300%) of motor full load current. Trip times shall be in accordance with manufacturers tolerances. Values in excess of one hundred twenty (120) seconds shall be investigated.

e. Insulation tests shall be made prior to termination.

D. Transformers:

1. General: Inspection and testing limited to motors rated 1/2HP and larger.

2. Visual and mechanical inspection for:

a. Physical and insulator damage.

b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.

c. Perform specific inspections and mechanical tests as recommended by manufacturer.

d. Proper winding connections.

e. Bolt torque level in accordance with NETA ATS, Table 1O. 1, unless otherwise specified by manufacturer.

f. Defective wiring.

g. Proper operation of fans, indicators, and auxiliary devices.

h. Removal of shipping brackets, fixtures, or bracing.

i. Free and properly installed resilient mounts.

j. Cleanliness and improper blockage of ventilation passages.

k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.

l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

m. Dissolved Gas Analysis (DGA Di-electric test, and moisture content test of oil.

3. Electrical tests:

a. A dielectric absorption test shall be made on motor and starter circuit. Polarization index shall be determined for motor winding.

b. A dielectric absorption test shall be made on motor winding. The thirty-sixty (30/60) second ratio shall be determined.

c. Insulation resistance tests:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

a) Winding-to-winding.

b) Winding-to-ground.

2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.

3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

5) Insulation resistance test results to compare within I percent of adjacent windings.

d. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.

e. Measure secondary voltages and adjust taps as directed by Engineer.

f. Turn to turn electrical testing for transformer integrity.

g. Measure no load and full load running current and voltage and compare to nameplate.

h. Observe proper operation and sequence of any reduced voltage starters.

i. Perform vibration base line test on motors greater than 50 HP. Amplitude to be plotted vs. frequency.

j. Perform vibration amplitude test on motors greater than 50 HP.

k. Check all protective devices in accordance with other sections of these specifications.

l. Perform over potential test on winding to ground.

m. The measurement shall be made with a 1,000 volt megohmmeter; however, the precautions noted in the tests for conductor test shall also be applied to the motors.

n. Insulation with resistance less than 10 megohms is not acceptable.

o. Measurements shall be recorded in a format similar to Form 26 05 08 - B, contained in this section.

p. After start-up of each motor, the current on each phase shall be measured.

1) At no load.

2) At defined load.

3) In-rush current.

4) Use Form 26 05 08 - B.

4. Test Values:

a. Dielectric absorption tests shall be made in accordance with test voltage listed as specified by manufacturer. Polarization tests shall before a ten (IO) minute duration. Sixty/thirty (60/30) second ratio tests shall be for a

one (1) minute duration. Polarization index readings less than threes hall be investigated. Sixty/thirty(60/30)second ratio readings less than 1.4 shall be investigated.

b. Motor measured full load current shall not exceed nameplate value.

c. Over potential test shall be made an eighty percent (80%) of twice rated voltage plus one thousand (1,000) volts.

d. Vibration amplitudes shall not exceed values furnished by manufacturer.

E. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

F. Switches:

1. Visual and mechanical inspection for:
   a. Proper blade pressure and alignment.
   b. Proper operation of switch operating handle.
   c. Adequate mechanical support for each fuse.
   d. Proper contact-to-contact tightness between fuse clip and fuse.
   e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
   f. Proper phase barrier material and installation.
   g. Proper fuse sizes and types as shown on single line diagram.
   h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.

2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

G. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:

a. Physical damage and proper connection in accordance with single line diagram.

b. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specifications.

e. Proper circuit identification.

f. Proper lug type for conductor material.

g. Proper lug installation.

h. Proper shield grounding on shielded instrumentation cable.

i. Proper terminations.

j. Proper circuit identification.

k. Proper termination of neutrals and grounds for correct operation of protective devices.

2. Electrical tests:

a. Insulation resistance tests:

1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.

2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.

3) Evaluate ohmic values by comparison with conductors of same length and type.

4) Investigate any values less than 50 megohms.

b. Perform continuity test to insure proper cable connection.

c. Measurements shall be made prior to connection of wires to any equipment. Ends of wires are to be taped with Scotch 33+ and be physically remote from all grounded surfaces by a minimum of 2".

d. Insulation resistance measurements shall be recorded using the following table.

PANEL DESIGNATION: UL4A	LOCATION: West Closet A

CIRCUIT	LOAD	CKT. CONF.	OUTLET TEST	WIRE SIZE	AMPS	MEGOHMS
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

e. Insulation with resistance of less than 10 megohms is typically not acceptable.

f. Insulation resistance test shall be performed at 1,000 volts dc for one-half (1/2) minute. Insulation resistance readings shall be recorded after the one-half minute time interval has elapsed.

g. If in the opinion of the Engineer the test results are unacceptable, the Contractor will correct the installation, material or labor at no additional cost to, and to the satisfaction of, the Engineer.

3. Test values:

a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.

b. Insulation tests shall be made prior to termination.

H. Dry type Transformers:

1. Visual and mechanical inspection for:

a. Physical and insulator damage.

b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.

c. Perform specific inspections and mechanical tests as recommended by manufacturer.

d. Proper winding connections.

e. Bolt torque level in accordance with NETA ATS, Table IO. 1, unless otherwise specified by manufacturer.

f. Defective wiring.

g. Proper operation of fans, indicators, and auxiliary devices.

h. Removal of shipping brackets, fixtures, or bracing.

i. Free and properly installed resilient mounts.

j. Cleanliness and improper blockage of ventilation passages.

k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.

l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

2. Electrical tests:

a. Insulation resistance tests:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

a) Winding-to-winding.

b) Winding-to-ground.

2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.

3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

5) Insulation resistance test results to compare within I percent of adjacent windings.

b. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.

c. Measure secondary voltages and adjust taps as directed by Engineer.

I. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

J. Safety Switches, 600 volts maximum.

1. Visual and mechanical inspection for:
   a. Proper blade pressure and alignment.
   b. Proper operation of switch operating handle.
   c. Adequate mechanical support for each fuse.
   d. Proper contact-to-contact tightness between fuse clip and fuse.
   e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
   f. Proper phase barrier material and installation.
   g. Proper fuse sizes and types as shown on single line diagram.
   h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.
      2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

K. Control Stations:

1. Visual and mechanical inspection for:
   a. Physical damage.
   b. Proper installation.
   c. Proper type and gasketing.
   d. Proper operation of pushbutton(s) and/or selector switch(es).

e. Proper identification on nameplate.

f. Proper control wiring:

1) Compare to elementary diagram.

2) Check for proper termination.

3) Check for proper conductor identification.

2. Electrical tests:

a. Control wiring tests:

1) Apply proper voltage to all circuits.

2) Check voltage levels at each termination.

3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.

b. Operational test by initiating control devices to affect proper operation.

L. Local Control Panel(s) – LCP

1. Visual and mechanical inspection for:

a. Physical damage.

b. Proper type and installation of cabinet.

c. Proper door closure and gasketing.

d. Proper operation of pushbutton(s) and/or selector switch(es).

e. Compliance with elementary diagrams and manufacturer's drawings.

f. Proper identification on nameplates.

g. Proper labeling of all devices both inside and outside.

h. Proper control wiring:

1) Compare to elementary diagram.

2) Check for proper termination.

3) Check for proper conductor identification.

i. Proper overload protection for motor(s) when its starter is included in the panel.

j. Proper breaker size and type.

k. Proper CT when required.

l. Proper terminal blocks.

2. Electrical tests:

a. Control wiring tests:

1) Apply proper voltage to all circuits.

2) Check voltage levels at each termination.

3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components. Insulation resistance to be one (1) megohm minimum.

b. Operational test by initiating control devices to affect proper operation of each control signal and discrete signal loop.

M. Operating and Control System

1. Visual and mechanical inspection for:

a. Physical damage.

b. Proper type and installation of cabinet.

c. Proper door closure and gasketing.

d. Proper operation of pushbutton(s) and/or selector switch(es).

e. Compliance with P&IDs and manufacturer's drawings.

f. Proper identification on nameplates.

g. Proper labeling of all devices both inside and outside.

h. Proper control wiring:

1) Compare to elementary diagram.

2) Check for proper termination.

3) Check for proper conductor identification.

i. Proper terminal blocks.

j. Equipment in compliance with these specifications.

k. Operating equipment in compliance with these specifications.

l. Operating screens in compliance with approved manufacturer's drawings.

m. Annunciator screens in compliance with approved manufacturer's drawings.

n. Alarm logs in compliance with approved manufacturers drawings.

2. Electrical tests:

a. Control wiring tests:

1) Apply proper voltage to all circuits.

2) Check voltage levels at each termination.

3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.

b. Operational test by initiating control devices to affect proper operation.

3.5 ADJUSTING

A. Subsystem Testing:

1. Shall occur after the proper operation of alarm and status contacts has been demonstrated and observed by the Engineer.

2. Shall occur after the process and control devices have been adjusted as accurately as possible.

3. It is intended that the Contractor shall adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

4. After initial settings have been completed:

   a. Each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract documents.

   b. After the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

5. Subsystems, in the context discussed here, shall mean individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, blowers, etc.

3.6 DEMONSTRATION

A. Commissioning:

1. Commissioning during the startup, shall not be attempted until all subsystems have been found to operate satisfactorily.

2. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable.

3. Simulation of process parameters shall be considered only upon receipt of a written request by the Contractor.

B. Motor current tabulation report shall reflect the values occurring during commissioning.

C. The indications of all switchgear ammeters and kilowatt meters, shall be recorded every half-hour during commissioning.

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

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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 THWN or 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. 18 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 THWN or 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

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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

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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: 5/8 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

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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 5,000 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 and occupied by plant personnel.

b. Outdoor and Corrosive Process Areas (NEMA 4X): Areas requiring corrosion resistant (NEMA 4X) construction are all outdoor areas unless noted otherwise and all indoor corrosive process areas. 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. 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.

d. 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.

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 4X[1] Outdoor	NEMA 4X[1] Indoor Corrosive	NEMA 12[1]	NEMA 7 Classified Explosion Proof/Process Area
Conduit (exposed)	GRS	RA[7] PGRS	RA PGRS	RA PGRS	PGRS
Conduit (concealed)[4]	EMT[3]	PGRS HDPE	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 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 HDPE conduit, continuous from device to device without pullboxes or conduit splices beneath grade due to high water table..
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 concealed 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.

D. HIGH DENSITY POLYETHELYNE PLASTIC PIPE (HDPE), OR POLYVINYL CHLORIDE (PVC) SCHEDULE 40, Based on Outside Diameter:

1. Conduit suitable for direct burial. 1” minimum size.
2. Fittings shall be threaded, glued, or heat welded type of same material as conduit. No splices are allowed underground in locations with high water table.
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.
6. Exterior underground conduits, all elbows shall be PVC coated GRS or Fiberglass.
7. All buried conduit between VFDs and motors.

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 risers through concrete floors, all embedded conduit, and all elbows of ductbanks underground.

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.
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

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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, HDPE-40.

B. Duct elbows, bends, and off-sets shall be per the manufacturer’s requirements. Metal or PVC conduits underground are not allowed.

C. No splices are allowed underground. HDPE shall be continuous from device to device above ground in order to minimize the entrance of water.

PART 3 - EXECUTION

3.1 CONDUIT BANKS

A. Each ductbank shall be completely encased in sand. 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 sand 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.

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.
   5. Nominal efficiency.
   6. NEMA design.
   7. Frame size.
   8. Enclosure.
   9. Winding insulation class and treatment.
   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 OWNER/CONTRACTOR shall complete the motor data sheet at the end of this Section for each and every motor supplied, and submit the completed forms to the ENGINEER 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 4,300 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. 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 (3600, 1800, 1200 & 900 RPM):
   a. 1 Hp through 2 Hp on a 143 T(C) to 213 T (C).
   b. 3 Hp through 5 Hp on a 182 T(C) to 254 T (C).
   c. 7.5 Hp through 10 Hp on a 213 T(C) to 284 TS
   d. 15 Hp through 25 Hp on 254 T to 326TS
   e. 30 Hp through 50 Hp on 286T to 404T
   f. 60 Hp through 100 Hp on a 364 T to 445T
   g. 125 Hp through 300 Hp on a 445TS to 5010 US
   h. Above 200 Hp, frame selection shall be defined on equipment data and motor data sheets.
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 250 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 project engineer. 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 optional 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. General Electric Company.
   2. Louis Allis (Division of MagneTek, Inc.)
   3. U.S. Motors Corporation
   4. Toshiba.
   5. Reliance.
   6. Baldor Gold Series.

B. The OWNER/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 ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

2.2 MOTORS LESS THAN ½ HORSEPOWER:

A. General

1. Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, and capacitor start induction run. Small fan motors may be split-phase or shaded pole type. Wound rotor or commentator type single phase motors are acceptable where its characteristics are necessary for the application. Conductors shall be copper.

B. Rating
   1. Motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1-10.35. Dual voltage rated motors are acceptable if all leads are brought out to the conduit box.
   2. Locked rotor current shall not be greater than specified in NEMA Standard MG1-10.36, Design “N”.

C. Enclosures
   1. Unless otherwise specified, motors shall be totally enclosed.

D. Bearings
   1. Motors shall be provided with sleeve-type or sealed ball bearings lubricated for 5 years normal use.

E. Insulation
   2. Comply with NEMA 1-1.65.
   3. Motors shall be furnished with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitude where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG 1-12.42 for a Class B insulation at ambient temperature of 40°C, and without using the service factor.

1.2 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.
      b. In addition, any changes caused by increase in motor horsepower shall be made by the OWNER/CONTRACTOR at no additional cost to the OWNER; such changes may involve circuit breakers, motor controllers, VFDs, motor and branch circuit and feeder conductors and conduit sizes, etc.
   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 OWNER/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 OWNER/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 OWNER/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.
6. High Efficiency Motors: Motors with a nameplate rating of 5 HP and above shall be “premium efficiency” units. Criteria stated herein, apply to horizontal motors without exception and apply to vertical motors insofar as they are available at time of construction.
    a. Efficiency shall be determined by the test as set forth in IEEE 112, Method B.
    b. If the inrush current due to the high efficiency design of the motor exceeds the available settings of the motor circuit protector, the motor circuit protector may be changed to a thermal magnetic circuit breaker, with the permission of the ENGINEER, at no additional cost to the OWNER.
        1) If is the OWNER/CONTRACTOR’S responsibility to perform the motor starting requirement coordination, and to notify the ENGINEER of any discrepancies.

B. Three Phase Motors
1. All motors 1/2 HP and larger shall be three phases unless otherwise indicated on Drawings, or specified elsewhere.
2. Voltage: All three phase motors shall be suitable for operation on 208, 230 and 460 VAC, unless otherwise indicated on the electrical plans.
3. NEMA Design:
    a. Electric Motors shall be NEMA Design B, (except as noted in equipment specifications for motors controlled as variable speed operation and other special motors), constant speed squirrel-cage induction motors having normal starting torque with low starting current.
    b. In no case shall starting torque or breakdown torque be less than the value specified in NEMA MG 1.
    c. Starting kilovolt ampere per horsepower shall not exceed values as specified in NEMA MG-1-10.37.
    d. Motors shall be suitable for operation on the following starting mechanisms as shown on the drawings:
        1) Across the line.
        2) Reduced voltage solid state starter.
        3) Variable frequency drive-inverter duty rated.
        4) 2 speed 2 winding.
4. Insulation:
    a. Comply with NEMA 1-1.65.

b. Motors shall be furnished with Class H insulation or with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitudes where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG1-12.42 for Class B insulation at a 40º C ambient, and without using the service factor.

5. Motor Bearings:
   a. Antifriction, re-greaseable, and filled initially with grease suitable for ambient temperature to 40ºC.
      1) Suitable for intended application and have AFBMA B-10 rating L-10 life of 60,000 hours or more.
      2) Bearing mounting shall be designed with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.

C. Vertical Motors
   1. Comply with the requirements for three phase motors except where the following requirements are more stringent.
   2. 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.
   3. All vertical motors shall have a Service Factor of 1.15.
   4. 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 60,000 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.

1.3 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.

1.4 ACCESSORIES

A. Conduit Boxes
   1. All vertical motors, shall have split-type cast metal conduit boxes.
   2. Boxes on motors other than open drip-proof shall be gasketed.
   1. Boxes shall be furnished with the size and number of openings as required for the conduits indicated on the Drawings.
   2. Boxes shall be rotatable through 360 degrees in 90 degree increments.
   3. 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. All motors 1 HP and larger shall be furnished with winding heaters where installed outdoors.
   2. Space heater ratings shall be 120 volts, single-phase, unless otherwise shown.
   3. 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.

1.5 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

1.6 OVER-TEMPERATURE PROTECTION

A. General
   1. Over-temperature protection devices shall provide a normally closed contact rated NEMA ICS Class B1 50. Relays or solid state contacts which are required shall be provided in an enclosure on or near the motor. Relay enclosure shall be in accordance with NEMA ICS-6 and shall be NEMA 4 for all motors.

B. Requirements
   1. Over temperature protection is not required for motors rated less than 25 horsepower.
   2. Over temperature protection for motors rated 25 horsepower to 199 horsepower shall be thermal switches, NEMA MG 1-12.57, Type 2.
   3. For motors from 200 horsepower to 399 horsepower shall include thermal switches, NEMA MG 1-12.57, Type 2 for shutdown. It shall also include a minimum of six 100 OHM Platinum RTD's embedded in the motor windings, and one 100 OHM for each bearing for temperature monitoring. Wiring to an external junction box shall be provided.
   4. Over temperature protection for motors rated 400 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. Coordinate with motor controller supplier to ensure RTD's match Multilin 369 requirements or similar RTD monitor for overtemperature shutdown.

1.7 SHAFT CURRENT PROTECTION

A. All motors coupled with a variable frequency drive (VFD) shall include a shaft grounding system. Acceptable systems include Mercotac Rotary Electrical Connectors, AEGIS SGR, or equal.

PART 2 - EXECUTION

2.1 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 energized.

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 pneumatic 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.

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.

D. Manual Operators and Interface Devices - Corrosive Areas

1. General Requirements:

a. NEMA 4X corrosion resistant.

b. Exterior parts to be made of high impact strength fiberglass reinforced polyester or other corrosion resistant materials.

c. Incorporating an internal neoprene boot which completely encloses all internal parts.

d. Industrial grade full-size 1 – 13/64” diameter.

2. Pushbutton

a. Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.

b. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

c. Color code:

1) Red - Stop

2) Green - Start

3) Orange - Open

4) Blue - Closed

d. As manufactured by:

1) Allen Bradley NEMA 4, 4X – 800H.

2) Crouse Hinds NPB1211.

3) Cutler-Hammer E34 Series.

4) Square D Type SK.

3. Selector Switches:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. As manufactured by:

1) Allen Bradley NEMA 4, 4X-800H.

2) Crouse Hinds NW 12221.

3) Crouse Hinds NSW 12321.

4) Cutler-Hammer E34 Series.

5) Square D Type SK.

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.

d. Light colors shall be as identified on the Plans.

e. As manufactured by:

1) Allen Bradley NEMA 4, 4X-800H.

2) Crouse Hinds NW 12221.

3) Crouse Hinds NSW 12321.

4) Cutler-Hammer E34 Series.

5) Square D Type SK.

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 18 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 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

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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 4X by Hoffman or equal in process or humid areas or 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

4. Water tight corrosion resistant stainless steel

    a. NEMA 4X in design, dust tight, water tight, and corrosion-resistant.

    b. 14 gauge, Type 304 Stainless Steel.

    c. Captive stainless steel cover screws threaded into sealed wells.

    d. Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.

    e. Finish

        1) Cover surface and sides, unpainted, brushed finish.

    f. Door fronts ground smooth.

    g. Specifically designed for use with flange mounted disconnect switches.

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 – (NOT USED)

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 utility shall be at 480/277 volt, three phase, four wire, 60 hertz AC with current ratings as indicated on the Drawings.

B. The CONTRACTOR shall install service conduits and conductors from the utility transformer location to the service entrance section. The installation shall be in accordance with the utility company's published requirements. The CONTRACTOR shall coordinate the installation with the utility.

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. The UFER ground system consists of a bare copper conductor, size as indicated in the Drawings, concrete encased 2" above the bottom of the foundation footing of the building or structure which is in direct contact with earth. The UFER ground will make a complete loop in the foundation and is bonded to the rebar steel at least in two locations. UFER ground connections shall be exothermic welds.

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

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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.

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. 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 / Eaton.

C. Or Equal.

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 21
MOTOR STARTERS

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. Motor Control Systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16, including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 28 13 – Fuses
3. Section 26 05 26 – Grounding and Bonding
4. Section 26 09 13 – Control Devices

B. The CONTRACTOR shall be familiar with all sections of these electrical specifications. He shall adapt his work to the work required of other trades to affect a complete and working system. Where this CONTRACTOR furnishes equipment, materials or installation which comprises a part of another CONTRACTOR's system, the item so furnished shall meet or exceed the requirements imposed on the other systems.

1.3 SHOP DRAWINGS/SUBMITTALS

A. Furnish complete working shop drawings of all control systems. Reference design documents for sequence, basic components, suggested piping, wiring, and dimensions. Submit manufacturer's data sheets for all equipment, devices and materials.

B. After initial review, make corrections requested and resubmit in clean format. Work only from final review set.

C. Maintain Record Drawings in the field. Clean up originals at completion of work and resubmit for OWNER's use in operation of the systems.

1.1 CONTROL DIAGRAMS

A. Control diagrams indicating the general control strategy are as shown on the Drawings. Actual circuitry will vary for the specific equipment furnished. Pilot light push-to-test wiring was omitted from the control diagrams for clarity.

B. Clarification of any function or device of any system not fully understood or recognized as being undefined should be requested from the ENGINEER during the

bidding period.

1.4 CLEANING AND LUBRICATION

All equipment shall be thoroughly cleaned by the CONTRACTOR before final acceptance. The CONTRACTOR shall provide lubrication for all equipment furnished by him.

1.5 TESTING AND ADJUSTING OF SYSTEM

A. During the testing and adjusting of the various electrical, control, and instrumentation systems, the CONTRACTOR shall have a representative present and available to adjust controls as required. The integrity and accuracy of each function and control point shall be demonstrated and reported.

1.6 CODES AND STANDARDS

A. The following standards shall be considered to be part of this specification insofar as they give definitions and describe requirements and tests which equipment supplied shall meet. They shall be the latest edition, including any addenda, supplements, or revisions thereto, in effect at the time of award of the purchase order. The equipment shall also meet any laws or requirements of the city, state or other regulatory bodies having jurisdiction over such apparatus, unless otherwise specified.

1. ANSI C57.13	Requirements for Instrument Transformers
	ANSI C89.1 (NEMA ST1) Specialty Transformers (except General Purpose Type)
3. NEMA AB-1	Molded Case Circuit Breakers
	NEMA ICS1 General Standards for Industrial Control and Systems
	NEMA 1CS2 Industrial Control Devices, Controllers and Assemblies
6. ANSI C1 (NFPA70)	National Electrical Code
	UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures
8. UL 508	Industrial Control Equipment
9. UL 845	Standard for Motor Control Centers
10. UL 1053	Ground Fault Sensing and Relaying Equipment
11. MSHA	Mine Safety and Health Administration

PART 2 - PRODUCTS

2.1 MOTOR CONTROLS NOT IN MOTOR CONTROL CENTERS

A. Furnish NEMA 4X stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all

components, numerically code all piping and wiring. Terminate all wiring at labeled terminal blocks. Provide engraved plastic labels for all panel face devices.

2.2 MOTOR STARTERS NOT IN MOTOR CONTROL CENTER

A. Furnish stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at terminal blocks. Provide engraved plastic labels for all panel face devices.

A. Combination magnetic starters shall be sized as indicated on the Drawings and shall be equipped as follows:

1. Motor Circuit Protector.
2. NEMA contactor rating indicated, NEMA size 1 minimum.
3. Control power transformer sized per load installed plus 50% spare capacity. Shall include fused primary and secondary.
4. Solid state overload relay – SymCom Motor Saver 777, Square D Motor Logic Plus, or Ge Multilin, Allen Bradley or equal.
5. Pilot devices and controls as shown on Drawings.
6. NEMA rated enclosure as shown on the Drawings.

C. Manual motor starters shall have:

1. ON pilot light.
2. Overload Protection: Melting alloy type thermal overload relays where indicated or required.
3. NEMA rated enclosure as shown on the Drawings.

PART 3 - EXECUTION

3.1 WIRING

A. All control wiring, 120 volt and below, shall be installed in conduit and wiring boxes.

B. Use no wiring smaller than #14 AWG and no conduit smaller than ¾ inch.

3.2 SPARES

A. Provide one spare manual motor for each size and type used.

B. Provide one NEMA size 1 contactor.

END OF SECTION

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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. Motor circuits shall be fused. Fuses, 0 to 600 amperes, for 1.15 service factor motors shall be sized not exceeding 125% of motor full load amperes shown on nameplate. Fuses, 0 to 600 amperes, for all other motors shall be sized not exceeding 115% of motor full load amperes. Fuses above 600 amperes for all motors shall be sized up to 150% of motor full load amperes. Abnormal motor starting conditions requiring

over sizing shall be coordinated with motor manufacturer.

B. 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.

C. 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 28 19
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install disconnects as described in Contract Documents, except those provided integral with equipment.

B. Related Sections

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 09 - Electrical Identification
3. Section 26 28 13 – Fuses

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, ratings, and specifications.

B. Refer to Section 26 05 00 for submittal requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturer

1. 1. Same MANUFACTURER as Motor Control Centers.

B. Disconnect Switches:

1. Heavy duty quick-make, quick-break type, fused, unless indicated otherwise. Provide a control switch for VFD fed motors which will disengage the VFD prior to opening the switch.
2. Provide interlock to prevent opening of door when switch is in ON position.
3. Provide means to lock switch in OFF position with padlock.
4. Disconnects for motor circuits shall be horsepower rated.
5. Where indicated on Drawings for small motors, disconnects shall be manual starter with thermal overload relay.
    a. Device shall have one pole per ungrounded conductor of motor.
    b. Provide overload relay to match motor full load amps.
    c. Equip with lockout device.
6. Enclosures:

a. Interior Dry locations - NEMA Type 12, or as indicated or required.

b. Exterior, Damp, or Wet Locations - NEMA Type 4X Stainless steel, or as indicated or required.

7. Fuses:

a. Fuse fused disconnects with dual-element time delay fuses and equip with rejection type fuse holders.

b. Fuses on shall be from single manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Label disconnects to indicate equipment served, such as Condensing Unit CU-1. Use 1/16 inch (1.6 mm) thick laminated plastic composition material with contrasting color core. Engraved letter shall be 1/4 (6 mm) inch high. Attach labels with screws.

END OF SECTION

SECTION 26 29 23
PULSE WIDTH MODULATED VARIABLE FREQUENCY DRIVES

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.

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. Qualified system integration will be by manufacturers approved and should use methods and procedures approval in writing by the VFD manufacturer prior to shipping the drive system to customer site. 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.

C. Drives for motors shall include an active front end filter to obtain the required harmonics mitigation. If a passive filter must be used, under no circumstances shall it introduce a leading power factor at any speed / loading of the motor.

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. Allen Bradley

B. Square D, Altivar Process 630

C. General Electric

D. WEG

E. Galt

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 required to meet this specification shall be performed by the VFD manufacturer or approved systems integrator only. Distributors and panel manufactures changes to the VFD products are specifically disallowed.

B. The VFD system shall consist of 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 1, 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 symmetrical interrupting capacity at least as high as the panel/MCC feeding it 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 adopted edition of IEEE 519 for each individual and total harmonic voltage and current distortion and as indicated in this specification. As per the latest adopted IEEE 519, 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 IEEE 519, 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 5th, 7th, and 11th 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 power factor 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. Motors over 60HP-399HP shall include thermal switch shutdown. For motors 400hp or more, the drive shall include an RTD monitoring module which shall monitor 8 – 100 ohm platinum RTD's in the motor and shutdown as recommended by the motor manufacturer. Note that for motors 200HP to 399HP shall also come with RTD's within the motor but that the RTD's will be monitored by the PLC system and alarm / shut down / trend within the PLC. See also the 26 05 74 - Electrical Motors specification.

J. Variable Frequency Drive Ratings:
1. The minimum drive efficiency for NEMA 1 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 the project elevation.
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 input to the diode bridges will be a full phase shifting isolation transformer with multiple secondaries. 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. In the future, it shall be possible to substitute any standard inverter-rated 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 a "Local", "Remote", "Manual" / "Auto", "Power On", "VFD Running" & "VFD Fault" indicating light or LED signal display. Included in the operator interface shall be a manual start, shop, bypass and fault reset button on the key pad or face of the panel.

B. The VFD shall include a customer selectable automatic restart feature. When enabled the control pad of the VFD it shall automatically attempt to auto restart after a trip condition resulting from over current, over voltage, over load, loss of utility power or out of saturation. It shall be programmable with up to 10 retries. For safety the drive will require manual restart for other 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), Emergency Stop, 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 communications protocols to the PLC. All status shall be communicated to the PLC including 3 phase voltage, 3 phase current, speed, status alarms, errors, etc.
4. Three programmable output relay contacts shall be rated for 250 VAC, 2 Amps. A separate 24 VDC power supply (50 mA) shall be available for control exterior control devices. Two programmable analog output signals shall be available to meet system requirements.
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 1, 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.

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.

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.

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 as well 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.
6. System control program providing built–in drive control or application specific configuration capabilities.
7. One system E-stop input (dry contact) coast to stop.
8. Input / output function shall match those indicated in the drawings.
9. 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.

    b. Two of each type of converter power semi-conductor.

    c. Two of each type of inverter power semi-conductor.

    d. One of each type of control board, gate firing board and communication board.

    e. One key pad assembly.

    f. Five of each type of panel lamp.

    g. Three of each size MOV's.

END OF SECTION

SECTION 26 32 00
STANDBY ENGINE GENERATOR

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM

A. Provide a standby power system to supply electrical power in event of failure of normal supply, consisting of a liquid cooled engine, an AC alternator, system controls, and sound attenuated enclosure with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.

B. Provide an automatic transfer switch, specified elsewhere, as part of a packaged system such that the system comes on-line fully automatically, and on restoration of utility power automatically retransfers load to normal power, shuts down the generator and returns to readiness for another operating cycle.

1.2 REQUIREMENTS OF REGULATORY AGENCIES

A. Conform to N.E.C. and applicable inspection authorities.

B. Transfer switch(s) to be labeled under UL 1008 and shall be programmed by a factory trained and authorized representative.

1.3 MANUFACTURER QUALIFICATIONS

A. These systems shall be supplied by a manufacturer who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of fifteen years, thereby identifying one source of supply and responsibility.

B. To be classified as a manufacturer, the builder of the generator set must manufacture at minimum engines or alternators.

C. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

D. Manufacturers:

1. Caterpillar
2. Cummins
3. Kohler
4. Generac

E. Substitutes: Proposed substitutions shall include complete submittal data, as specified herein and required elsewhere, clearly denoting and all deviations and/or exceptions to the equipment specified. The complete proposed substitution must be submitted in accordance with the Standard General Conditions and Supplementary Conditions.

1.4 WARRANTY

A. The standby electric generating system components, complete engine-generator and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of 36 months or 3,000 hours, whichever is greater. This warrantee shall include freight, shipping, labor, parts, etc. for the entire generation system. Such defective parts shall be repaired or replaced at the manufacturer’s option, free of charge for travel and labor. An additional 4 years of the manufacturer's standard warranty coverage shall be provided. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

1.5 SUBMITTALS

A. Provide complete sets of Engineering Submittal for approval, prior to production release, showing all components, in addition to the engine and generator. Submittals shall show compliance with these specifications.

B. Provide sizing calculations showing the submitted units ratings at altitude and ambient temperature.

C. Refer to Sections 01 30 00 and 26 05 00 for additional submittal requirements.

PART 2 - PRODUCTS

2.1 ENGINE

A. The prime mover shall be a liquid cooled, diesel fueled, turbo charged, after cooled engine of 4-cycle design. The unit requires a minimum rated output as specified in these documents at an operating speed of 1800 RPM.

B. The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system providing visual diagnostic means to determine if the system is operating with a normal engine coolant level. The radiator shall be designed for operation in the ambient temperature conditions listed in this document. Fan and radiator shall be sized for the critical grade sound attenuated enclosure of the generator.

C. The intake air filter with replaceable element must be mounted on the unit. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter with internal bypass and replaceable elements. Engine coolant and oil drain extension must be provided to outside of the mounting base for cleaner and more convenient engine servicing. A fan guard must be installed for personnel safety.

D. The engine shall have a battery charging DC alternator with a transistorized voltage regulator. Remote 2-wire starting shall be by a solenoid shift, electric starter.

E. Engine speed shall be governed by electronic governor to maintain alternator frequency within .5% from no load to full load alternator output. Steady state regulation is to be 0.25%.

F. The engine fuel system shall be designed for operation with Diesel fuel. A fuel shutoff solenoid and all fuel lines must be installed at the point of manufacture.

G. Sensing elements to be located on the engine for low oil pressure shutdown, high coolant temperature shutdown, low coolant level shutdown, overspeed shutdown and overcrank protection. These sensors are to be connected to the control panel using a wiring harness with the following features: wire number labeling on each end of the wire run for easy identification, a molded rubber boot to cover the electrical connection on each sensor to prevent corrosion and all wiring to be run in flexible conduit for protection from the environment and any moving objects.

H. Engine Manufacturers:

1. Caterpillar
2. Cummins
3. John Deere
4. GM
5. Perkins
6. Volvo
7. Generac
8. Detroit Diesel

2.2 CAPABILITY REQUIREMENTS

A. Generators shall have the following operation capabilities:

Generator No. 1	
Site Rated kW rating	1000 kW @ 0.8 Power Factor . Confirm with drawings.
Fuel -	Diesel
Voltage-	480/277, Parallel Wye
Phase -	Three (3)
Frequency (Hz)	60
Altitude -	5000 feet
Ambient Temperature	-30 degrees F to 110 degrees F.

Main Breaker, Solid State with GFP, 100% Rated – Sizes as indicated on the drawings.

2.3 FACTORY INSTALLED EQUIPMENT

A. Generator Set(s) shall have solid state controller(s) as standard. Controls shall be factory installed and tested. Controllers shall be reliable, durable and accurate, have easy to read meters. Three spare inputs and one spare output shall be provided for customer programmed set points. Controller shall use an SAE format, the panel shall zero in on the affected system and identify the component responsible for the failure. Key-pad programmable set points, following items shall be standard features of controller:

1. Digital (LCD) Indication
    a. AC Voltage (L-L)
    b. AC amps
    c. System Diagnostics
    d. Frequency
    e. DC Voltage
    f. Coolant Temperature
    g. Oil Pressure
    h. RPM
    i. Hours Run
2. Controls
    a. Auto Start/Stop
    b. Emergency Stop
    c. Lamp Test
    d. Cycle Crank
    e. Voltage Control
    f. Cooldown Timer
    g. Phase Selector Switch
3. Indicating Lights
    a. Low Oil Pressure
    b. High Coolant Temperature
    c. Overspeed
    d. Overcrank
    e. Emergency Stop
    f. Fault Shutdown *
    g. Fault Alarm *
    h. Not in auto
    i. Pre-Alarm

1) 1 Spare Inputs – Customer Programmable

B. A heavy duty, lead acid battery set shall be provided by the generator set manufacturer of adequate voltage and amperage capacity to start and operate the engine. Provide all intercell and connecting battery cables as required.

C. The manufacturer shall supply and install its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system.

D. The engine shall have a unit mounted, thermostatically controlled water jacket heater to aid in quick starting. It will be of adequate wattage as recommended by the engine manufacturer. The contractor shall provide proper branch circuit from normal utility power source.

E. An oil heater and thermostat shall be installed in the engine oil pan at the factory as recommended by manufacturer.

F. A block heater and thermostat shall be installed in the engine block at the factory as recommended by manufacturer.

G. Provide a thermostatically controlled blanket type battery heater to increase engine battery capacity for cold weather starting.

H. Provide an automatic dual rate battery charger manufactured by the engine-generator set supplier. The automatic equalizer system shall monitor and limit the charge current to 10 amps. The output voltage is to be determined by the charge current rate. The charger must have a maximum open circuit voltage of 35 volts and be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

2.4 THE FOLLOWING EQUIPMENT IS TO BE PROVIDED BY THE ENGINE-GENERATOR SET MANUFACTURER AND SHIPPED LOOSE WITH THE UNIT:

A. The manufacturer will supply its recommended flexible fuel line to connect the engine to the external fuel source. On stationary applications the fuel line shall match the fuel fitting on the unit base rail and have braided stainless steel covering with brass fittings.

B. Installation acceptance test to be conducted on-site shall include a “cold start” test, a six-hour full load test, and a on-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank for 100% rated load and make temporary connections for full load test.

2.5 ALTERNATOR

A. The alternator shall be a 4-pole revolving field type, 12 lead, wired for or 277/480 VAC, three phase, 60 Hz with a brushless, PMG exciter. Photosensitive components will not be permitted in the rotating exciter. The stator shall be direct connected to the engine to insure permanent alignment. The generator shall meet temperature rise standards for Class "H" insulation; operate within Class "F" standards for extended life. All leads must be extended into an AC connection panel. The alternator shall be protected by internal thermal overload protection and an automatic reset field circuit breaker.

B. One step load acceptance shall be 100% of nameplate rating and meet the requirements of NFPA 110 paragraph 5-13.2.6. The generator set and regulator must sustain at least 90% of rated voltage for 10 seconds with 250% of rated load at near zero power factor connected to its terminals when equipped with direct or brushless excitation. 300% short circuit current must be selectable on units equipped with permanent magnet exciters. Generators equipped with permanent magnet exciters not allowing the selection of the short circuit current ratings are not allowed.

C. A solid state voltage regulator designed and built by the engine-generator set manufacturer must be used to control output voltage by varying the exciter magnetic field to provide + or - 1% regulation during stable load conditions. Should an extremely heavy load drop the output frequency, the regulator shall have a voltage droop of 4 Volts/Hertz to maximize motor starting capability. The frequency at which this droop operation begins must be adjustable, allowing the generator set to be properly matched to the load characteristics insuring optimum system performance. Additional rheostats for matching generator voltage, droop, and stability characteristics to the specific load conditions must be available.

D. The voltage regulator must contain a limiting circuit to prevent output voltage surges in excess of 125% of rated voltage during generator set operation. On loss or near loss of the voltage sensing signal, the voltage regulator must be capable of shutting down to prevent an overvoltage condition from occurring. It must have a second mode of operation allowing 300% of rated current to flow through the electrical distribution circuit(s) for ten (10) seconds under the same conditions. Voltage regulators not capable of selecting either mode of operation are not acceptable. LED indication will be provided on the regulator to monitor the sensing (yellow), excitation (green), and output circuit (red).

E. A NEMA 1 panel that is an integral part of the generator set must be provided to allow the installer a convenient location in which to make electrical output connections. An isolated neutral lug must be included by the generator set manufacturer to insure proper sizing.

2.6 MOUNTING

A. The electric plant shall be mounted with vibration isolators on a welded steel base that shall permit suitable mounting to any level surface.

2.7 PROVIDE FOLLOWING ITEMS INSTALLED AT FACTORY

A. The unit mounted main line circuit breaker shall have an internal set of form "C" contacts that change state whenever the breaker is opened or closed. Lamps on the generator control panel shall indicate breaker position and screw terminals in the control panel shall provide appropriate system DC voltage for remote annunciation.

B. A solid state, thermal magnetic UL listed main line circuit breaker shall be mounted in the AC connection panel. The line side connections are to be made at the factory. A system utilizing a manual reset field circuit breaker and current transformers is unacceptable.

2.8 CONTROLS

A. All engine alternator controls and instrumentation shall be designed, built, wired, tested and shock mounted in a NEMA 12 enclosure to the engine-generator set by the manufacturer. It shall contain panel lighting, a fused DC circuit to protect the controls and a +/-5% voltage adjusting control. This panel must be able to be rotated 90 degrees in either direction for correct installation.

B. The engine-generator set shall contain a complete 2 wire automatic engine start-stop control which starts the engine on closing contacts and stop the engine on opening contacts. A cyclic cranking limiter shall be provided to open the starting circuit after eight attempts if the engine has not started within that time. Engine control modules must be solid state plug-in type for high reliability and easy service. The engine controls shall also include a 3-position selector switch with the following positions: AUTO/OFF/RUN. Auto will allow full automatic operation, off disables any engine start, run starts the engine. An emergency stop switch, panel fuse, 5% voltage adjust rheostat and RS485/Ethernet communications port shall be panel mounted.

C. A micro-processor based digital control panel will be supplied. It shall simultaneously display all operating conditions including:

1. AC Volts
2. AC Amperes
3. Frequency
4. Power Factor
5. KW Output
6. Oil Pressure
7. Water Temperature
8. Fuel level
9. Battery Voltage
10. Run Time Hours. It shall have individual LED's to indicate:
    a. Selected Phase
    b. High or Low AC Voltage
    c. High or Low Battery Voltage
    d. High or Low Frequency

e. Low and Pre-Low Oil Pressure

f. Low Water level

g. Low Water Temperature

h. High and Pre-High Engine Temperature

i. High, Low and Critically Low Fuel Levels and Fuel in Rupture Basin

j. Emergency Stop

k. Overcrank

l. Overspeed

m. Unit not in Automatic Mode

n. Status of Main Line Circuit Breaker(where applicable)

o. Program Mode

11. Two additional LED's for future programming. A keypad shall allow local programming of the units operating parameters as well as testing and resetting of the alarm LED's. The keypad shall include the phase selector function.

D. The following equipment is to be installed at the engine-generator set manufacturer's facility:

1. A red mushroom type emergency stop switch shall be mounted on the generator control panel and when pressed shall shutdown the engine/generator requiring a manual reset before operation can resume.

2. A sensor shall be installed in the sub-base fuel tank indicating 50% of fuel remaining (where applicable). A "Low Fuel" lamp on the control panel and on the remote annunciator will illuminate when this level is reached. The alarm shall be available to the Alarm System.

2.9 UNIT ACCESSORIES

A. Generator set housing shall be provided factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in the ambient conditions previously specified. The housing shall have hinged side-access doors an rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer’s standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating which meets the following requirements:

1. Primer Thickness, 0.5-2.0 mils

2. Top Coat Thickness, .08-1.2 mils

3. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall not exceed 50%

4. Crosshatch Adhesion, per ASTM D3359-93, 4B-5B

5. Impact Resistance, per ASTM D2794-93, 120-160 inch pounds

6. Salt Spray, per ASTM B117-90, 1000+ hours
7. Humidity, per ASTM D2247-92, 1000+ hours
8. Water Soak, per ASTM D2247-92, 1000+ hours

B. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

C. The generator set shall be provided with sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 72 dB(A) 7 meters from the nearest point of the proposed generator installation location and 60dB minimum at the edge of the nearest residential lot. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass. The engine-generator set shall be factory enclosed in a 12 gauge steel enclosure constructed with corner posts, uprights and headers. The roof shall aid in the runoff of water and include a drip edge. The enclosure shall be coated with electrostatically applied power paint, baked and finished to manufacturer's specifications. The enclosure shall be completely lined with 1" thick minimum, UL 94 HF-1 listed, sound deadening material. This material must be of a self extinguishing design. The enclosure is to have large, hinged, removable doors to allow access to the engine, alternator and control panel. Hinges and all exposed fasteners will be stainless steel. Each door will have lockable hardware with identical keys. Padlocks do not meet this specification. The critical silencer shall be mounted within the enclosure to further reduce the unit sound level and provide a clean, smooth exterior design. The enclosure shall include sound insulated, baffled air intake hoods and air exhaust hoods. The generator set shall be sized to account for losses in sound baffles and critical grade appurtenances.

D. The following equipment is to be provided by the engine-generator set manufacturer:
   1. Spring type vibration isolators to mount between the engine mounting base and fuel tank frame to eliminate noise, reduce transmitted vibration and provide earthquake protection.

E. Provide a dual wall sub base fuel tank with day tank fuel level controls.
   1. The sub base fuel tank will contain 48 hours of diesel fuel to support the generator set for a period of 48 hours at full load. The sub base fuel tank shall be listed under UL 142, sub section entitled "Special Purpose Tanks EFVT" category, and will bear their mark of "UL Approval" according to their particular classification.
   2. Secondary Containment Generator Base Tank:
      a. Aboveground steel secondary containment rectangular tank for use as a sub base for diesel generators intended to be installed in accordance with the standards of NFPA 30, 37 & 110. These tanks have provisions for monitoring the annular (containment) space for leakage. (Both the inner and outer containment tanks must provide for emergency venting per NFPA 30.).

b. Rectangular, heavy gauge, welded steel construction.
c. Double wall with a sealed, separately vented, integral fuel containment basin.
d. Reinforced steel box channels for generator support.
e. Full height gussets provided at genset mounting holes.
f. Interior coated with a solvent-based rust inhibitor.
g. Top-mounted fuel gauge.
h. Engine fuel supply and return drop tubes.
i. Day tank supply and return drop tubes.
j. Raised fuel fill.
k. Mounting brackets for optional pump and control.
l. Ground clearance to minimize bottom rusting.
m. Integral lifting points.
n. Tanks are leak-checked to ensure integrity of weld seams prior to shipment.

3. Ancillary Equipment:

   a. The base tank will be equipped with accessories required for the application and by NFPA 30 for this application. The accessories shall include but not be limited to:

      1) Low fuel level float switch, set at 10% level.
      2) High fuel level / overfill prevention, audible alarm, set at 90% level.
      3) Overfill prevention float valve or solenoid on tank fill port, set at 95% level.
      4) Fill port drop tube to within 6” of the bottom of the tank.
      5) Spill containment bucket or basin around fill port.
      6) Interstitial monitoring float switch (leak detection).
      7) Normal vents, extended 12 feet above grade, flame arrester caps.
      8) Emergency vents, on tank and containment basin.
      9) Provisions for connection of grounding conductor.
      10) Tank calibration chart in inches to gallons.
      11) Warning Signage; No Smoking, Flammable Liquids, Diesel Fuel, NFPA 704 Placards.
      Fuel level transmitter

4. The tank shall include independent level sensors and remote dry contacts for a critical high fuel shutdown. The alarm condition activates a red light on tank control panel, coils on a relay for remote annunciation and closes a normally open solenoid valve in the fuel inlet piping.

5. All alarms and level controls shall be factory assembled and wired so that only a 115 VAC power supply need be applied to make the tank control system functional. The remote alarm dry contacts will require separate wiring and power supply.

6. A fuel strainer shall be provided and installed up stream of all solenoid valves in the fuel inlet piping.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:

1. Verifying all safety shutdowns are functioning properly.
2. Single step load pick-up per NFPA 110, Paragraph 5-13.2.6.
3. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.

3.2 OWNER'S MANUALS

A. Three (3) sets of OWNER's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

3.3 INSTALLATION

A. CONTRACTOR shall install the complete electrical generating system including all fuel connections in accordance with the manufacturer's recommendations as reviewed by the ENGINEER.

B. CONTRACTOR to supply all lugs required for external load connections.

3.4 SERVICE

A. Supplier of the electric plant and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the OWNER maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

3.5 STARTUP AND CHECKOUT

A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:

1. Engine Generator/ATS Testing: See Section 17100 for requirements

a) Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the panelboard. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment. The test voltage shall be 100 volts dc, applied for 30 seconds between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

b) R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)
c) R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)
d) Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

2. Circuit breakers and switchgear shall be examined and tested in accordance with the manufacturer's published instructions for functional testing.

B. Inspections

The following inspections shall be performed jointly by the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1. Drive belts.
2. Governor type and features.
3. Engine timing mark.
4. Starting motor.
5. Starting aids.
6. Coolant type and concentration.
7. Radiator drains.
8. Block coolant drains.
9. Coolant fill level.
10. Coolant line connections.
11. Coolant hoses.
12. Combustion air filter.
13. Intake air silencer.
14. Lube oil type.
15. Lube oil sump drain.
16. Lube-oil filter.
17. Lube-oil level indicator.
18. Lube-oil fill level.
19. Lube-oil line connections.
20. Lube-oil lines.
21. Fuel type.
22. Fuel-level. (where applicable)
23. Fuel-line connections.
24. Fuel lines.
25. Fuel filter.
26. Access for maintenance.
27. Voltage regulator.
28. Battery-charger connections.
29. Wiring & terminations.
30. Instrumentation.

31. Hazards to personnel.
32. Base.
33. Nameplates.
34. Paint.
35. Exhaust-heat system.
36. Exhaust muffler.
37. Switchboard.
38. Switchgear.
39. Access provided to controls.
40. Enclosure is weather resistant.
41. Engine & generator mounting bolts (application).

C. Performance Tests

1. In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.
    1. Continuous Engine Load Run Test:
        Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:
        Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.
        Pressure: Lube-oil.
        Temperature: Coolant, Lube-oil, Exhaust, Ambient.
        a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.
        b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.
        c. Operate the engine generator-set for 2 hours at 75% of Service Load.
        d. Increase load to 100% of Service Load and operate the engine generator-set for 4 hours.

2. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart

recorders or comparable digital recorders, as approved by the Contracting Officer.

Tabular data shall include the following:

1) Ambient temperature (at 15 minute intervals).
2) Generator output current (before and after load changes).
3) Generator output voltage (before and after load changes).
4) Frequency (before and after load changes).
5) Generator output power (before and after load changes.
6) Graphic representations shall include the actual instrument trace of voltage and frequency showing:

b) Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.
c. With the unit at no load, apply the Maximum Step Load Increase.
d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.
e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100% of Service Load.
f. Apply the Maximum Step Load Increase.
g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.
h. Repeat steps c. through g.

D. Generator Fail Test:

1. Test the capability of each engine-generator set to pick up the entire load if the alternate generator fails. During operations record load-sharing characteristics of each set in parallel operation. Data taken shall include the following:
   a) Ambient temperature (at 15 minute intervals).
   b) Generator output current (before and after load changes).
   c) Generator output voltage (before and after load changes).
   d) Power division and exchange between generator sets.
   e) Real power (watts) and reactive power (vars) on each set.
2. Combinations
   a) Connect each set, to the load of the system, operating at service load, until all possible two-unit-in-parallel combinations have been achieved. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive loads. Document stabilization of voltage and frequency within

specified bandwidth, and voltage and frequency stability and transient response in the following steps for each combination.

E. Automatic Operation Tests for Engine Generator Set:
1. The automatic operating system shall be tested to demonstrate automatic starting, the response to loss of operating engine-generator sets, and paralleling of each engine-generator set. The loads for this test shall utilize actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:
   a) Ambient temperature (at 15 minute intervals).
   b) Generator output current (before and after load changes).
   c) Generator output voltage (before and after load changes).
   d) Generator output frequency (before and after load changes).
   e) Power of each generator set.
   f) Real and reactive power on each set.
2. Initiate loss of the preferred power source and verify the specified sequence of operation.
3. Verify resetting of automatic starting and transfer logic.

F. Automatic Operation Tests for Stand-Alone Operation
1. The automatic loading system shall be tested to demonstrate automatic starting, of each engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:
   a) Ambient temperature (at 15 minute intervals).
   b) Generator output current (before and after load changes).
   c) Generator output voltage (before and after load changes).
   d) Generator output frequency (before and after load changes).
      1) Initiate loss of the primary power source and verify automatic sequence of operation.
      2) Restore the primary power source and verify sequence of operation.
      3) Verify resetting of controls to normal.

G. Pull the Plug System Test:
1. The contractor shall record all voltages and frequencies prior to and after each sequence of the test.
2. Contractor shall simulate a power outage by opening all circuit breakers which feed automatic transfer switches. The contractor shall then observe that the engines generators start up and run and that the transfer switches take the load. Time delays for start up and transfers of each transfer switch shall be recorded. The contractor shall verify proper operation of each automatic transfer switch.

3. Contractor shall verify proper startup and operation of all equipment including fans, pumps, chillers, alarm and monitoring systems and lighting systems.
4. Contractor shall verify proper operation of lighting systems to insure that emergency lighting has returned. Contractor shall verify the proper operation of each fan coil unit.
5. The contractor shall verify proper operation of each UPS to insure that

power to critical loads was not interrupted.

6. The contractor shall then restore power to transfer switches by closing each of these breakers and verifying that all systems time out and retransfer, that generators cool down and subsequently shut off. All time delays shall be recorded.
7. Contractor shall then verify proper restart of all equipment as noted above.
8. Contractor shall then verify that each UPS maintained power to the critical load during the retransfer.
9. Contractor shall then verify that all lighting and non UPS systems return to normal operation.

END OF SECTION

SECTION 26 35 53
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
   E. IEEE C62.43-2005
   F. IEEE C62.45-2002
   G. IEEE C62.48-2005
   H. IEEE C62.62-2010
   I. UL 96A
   J. 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

1. 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	●	●	●	●

   F. 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.

   G. 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

   A. 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.

B. 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.

C. 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.

D. 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.

E. 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.

   b. 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.

c. 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.

d. 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.

F. 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.

G. 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.

H. 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.

    b. 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

1. 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.
2. 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

1. 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

A. 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.

B. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway

C. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway

D. 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

E. 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.

F. 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.

G. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

H. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.06 SERVICE ENTRANCE REQUIREMENTS

A. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments.

2.07 EXAMINATION

2.08 FACTORY TESTING

A. 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

A. 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.

2.11 WARRANTY

A. 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 36 23
AUTOMATIC TRANSFER SWITCHES

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. This Section includes transfer switches rated 600 V and less, including the following:

B. Automatic transfer switches

1. Related Sections include the following:

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.

2. Single Line Diagram: Show connections between transfer switch, power sources and load

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.

2. Internal electrical wiring and control drawings.

3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.

4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.

C. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

E. Warranty documents demonstrating compliance with the project’s contract requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than (eight hours or appropriate time period designated for Project) from time of notification.

1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.

3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

B. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

D. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:

1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.

2. CSA 282, Emergency Electrical Power Supply for Buildings, and CSA C22.2, No. 14-M91 Industrial Control Equipment

3. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.

4. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches

5. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

6. EN55011, Class B Radiated Emissions and Class B Conducted Emissions

7. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity

8. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity

9. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity

10. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity

11. IEC 1000-4-6 Conducted Field Immunity

12. IEC 1000-4-11 Voltage Dip Immunity

13. IEEE 62.41, AC Voltage Surge Immunity

14. IEEE 62.45, AC Voltage Surge Testing

E. Comply with NFPA 99 – Essential Electrical Systems for Healthcare Facilities

F. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.

G. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of one (1) year from registered commissioning and start-up, or eighteen (18) months from date of shipment.

H. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Owner no fewer than 2 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner’s written permission.

3. Do not energize any new service or distribution equipment without notification and permission of the Owner

1.6 COORDINATION

A. Size and location of concrete bases and anchor bolt inserts shall be coordinated. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See section "INSTALLATION" for additional information on installation

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cummins Power Generation
2. Caterpillar
3. ASCO 7000 Series
4. Kohler
5. Generac

B. Equipment specifications for this Project are based on automatic transfer switches manufactured by Cummins Power Generation. Switches manufactured by other manufacturers that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.

C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Provide transfer switches in the number and ratings that are shown on the drawings.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test. Fault current rating shall be fully rated with breakers protecting switch. Coordinate with panelboard vendor.

D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches). All switches shall include a center off delay (delayed transition) function to allow for motor loads to slow.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.

2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.

3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.

5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.

6. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.

    a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality

7. Transfer switches designated on the drawings as “4-pole” shall have a full current-rated neutral bar with lugs.

H. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

I. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.

J. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:

1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.

2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.

3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Indicated current ratings:

1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.

2. Main contacts shall be rated for 600 VAC minimum.

3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).

C. Relay Signal: Control shall include provisions for addition of a pre-transfer relay signal, adjustable from 0 to 60 seconds, to be provided if necessary for elevator operation, based on equipment provided for the project.

D. Transfer switches that are designated on the drawings as 4-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

E. Automatic Transfer Switch Control Features

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be

monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.

2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.

3. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 60 seconds.

4. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.

5. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

6. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational.

7. Transfer switch shall be equipped with load shed option to drop load if the fire pump starts. See sequence of operation.

F. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels.

1. The indicator panel LEDs shall display:

   a. Which source the load is connected to (Source 1 or Source 2)

   b. Which source or sources are available

   c. When switch is not set for automatic operation, the control is disabled

   d. When the switch is in test/exercise mode

2. The indicator shall have pushbuttons that allow the operator to activate the following functions:

    a. Activate pre-programmed test sequence

    b. Override programmed delays, and immediately go to the next operation

    c. Reset the control by clearing any faults

    d. Test all of the LEDs by lighting them simultaneously

3. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:

    a. AC voltage for all phases, normal and emergency

    b. Source status: connected or not connected.

4. The display panel shall be password-protected, and allow the operator to view and make adjustments:

    a. Set nominal voltage and frequency for the transfer switch

    b. Adjust voltage and frequency sensor operation set points

    c. Set up time clock functions

    d. Set up load sequence functions

    e. Enable or disable control functions including program transition

    f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history

G. Control Functions: Functions managed by the control shall include:

1. Software adjustable time delays:

    a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)

    b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)

    c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)

d. Engine cooldown: 0 to 30 minutes (default 10 min)

e. Programmed Delayed Transition (Center Off Delay): 0 to 60 seconds (default 3 sec)

2. Undervoltage sensing: three-phase normal, three-phase emergency source.

3. Over-voltage sensing: three-phase normal, three-phase emergency source.

4. Over/under frequency sensing:

a. Pickup: +/- 5 to +/-20% of nominal frequency (default 10%)

b. Dropout: +/-1% beyond pickup (default 1%)

c. Dropout time delay: 0.1 to 15.0 seconds (default 5 sec)

d. Accurate to within +/- 0.05 Hz

5. Voltage imbalance sensing:

a. Dropout: 2 to 10% (default 4%)

b. Pickup: 90% of dropout

c. Time delay: 2.0 to 20 seconds (default 5 sec)

6. Phase rotation sensing:

a. Time delay: 100 msec

7. Loss of single-phase detection:

a. Time delay: 100 msec

H. Control features shall include:

1. Programmable genset exerciser: A field-programmable control shall periodically start and run the generator with or without transferring the load for a preset time period, then re-transfer and shut down the generator after a preset cool-down period.

2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.

3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times

transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.

4. Re-Transfer Inhibit Switch: Inhibits automatic re-transfer control so automatic transfer switch will remain connected to emergency power source as long as it is available regardless of condition of normal source.

5. Transfer Inhibit Switch: Inhibits automatic transfer control so automatic transfer switch will remain connected to normal power source regardless of condition of emergency source.

I. Control Interface

1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

J. Engine Starting Contacts

1. One isolated and normally closed pair of contacts rated 10A at 32 VDC minimum.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

C. Indicating Lights: Grouped for each transfer switch monitored.

D. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

E. Switch in test mode.

F. Lamp Test: Push-to-test or lamp-test switch on front panel.

G. Malfunction of annunciator or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation.

H. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation. The remote annunciation system shall not prevent transfer to the alternate source when the primary power source fails, nor prevent return to the primary source if the alternate source fails.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Floor-mounted transfer switches (except drawout switches supported by wheeled carriages, which must be rolled out at floor level) shall be mounted on concrete bases complying with the following requirements:

a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Annunciator Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

C. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 SOURCE QUALITY CONTROL

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer’s representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.

1. Perform recommended installation tests as recommended in manufacturer’s installation and service manuals.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Verify time-delay settings.

c. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

3.5 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, and emergency operation procedures.

2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

END OF SECTION

SECTION 26 41 00
LIGHTNING PROTECTION

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. Air terminals and interconnecting conductors.

B. Grounding and bonding for lightning protection.

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 REFERENCES

A. LPI-175 - Lightning Protection Installation Standard.

B. LPI-176 - Lightning Protection System Material and Components Standard.

C. LPI-177 - Inspection Guide for LPI Certified Systems.

D. NFPA 78 - Lightning Protection Code.

E. UL 96 - Lightning Protection Components.

F. UL 96A - Installation Requirements for Lightning Protection Systems.

1.4 SYSTEM DESCRIPTION

A. Lightning Protection System: Conductor system protecting consisting of air terminals on roofs, roof-mounted mechanical equipment, chimneys and stacks, parapets, bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors.

1.5 SUBMITTALS FOR REVIEW

A. Section 26 05 00 – Electrical General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

C. Product Data: Provide dimensions and materials of each component, and include indication of listing in accordance with UL 96.

1.6 PROJECT CLOSEOUT SUBMITTALS

A. Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 70.

B. Perform Work in accordance with UL 96A

C. Perform Work in accordance with LPI-175

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum three years experience and member of the Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum three years experience and certified by the Lightning Protection Institute.

1.9 REGULATORY REQUIREMENTS

A. Product Listing: UL 96 and LPI-176.

B. System shall be UL listed and certified.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.11 COORDINATION

A. Coordinate work with roofing and exterior and interior finish installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND INSTALLERS

A. VFC Corporation. North Salt Lake, Utah.

B. Robbins Lightning, Inc.

2.2 COMPONENTS

A. Air Terminals: Copper solid with adhesive bases for single-ply roof installations.

B. Air Terminal for Chimney: Lead-coated copper.

C. Grounding Rods: Solid copper

D. Ground Plate: Copper.

E. Conductors: Copper cable

F. Connectors and Splices: Bronze

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 78, UL 96A and LPI-175.

B. Connect conductors using exothermic welding process. Protect adjacent construction elements and finishes from damage. All welds shall be witnessed by the OWNER.

C. Bond exterior metal bodies on building to lightning protection system and provide intermediate level interconnection loops 60 feet (18 m) on center.

3.2 FIELD QUALITY CONTROL

A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and labeling of the lightning protection system in accordance with UL 96A.

B. Obtain the services of the Lightning Protection Institute to provide inspection and certification of lightning protection system in accordance with LPI-177.

END OF SECTION

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SECTION 26 51 13

INTERIOR LUMINAIRES

PART 1 - GENERAL

1.01 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. Interior luminaires and accessories.
2. Emergency lighting units.
3. Exit signs.
4. Ballasts.
5. Fluorescent lamp emergency power supply.
6. Lamps.
7. Luminaire accessories.

1.02 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section 260500- Electrical General Requirements.

1.03 REFERENCES

A. ANSI C78.379 - Electric Lamps - Incandescent and Issued October 1993 High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. ANSI C82.1 - Ballasts for Fluorescent Lamps -Specifications.

C. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).

D. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

E. NFPA 70 - National Electrical Code.

F. NFPA 101 - Life Safety Code.

1.04 SUBMITTALS FOR REVIEW

A. Section 260500 - Electrical General Requirements

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.05 SUBMITTALS FOR CLOSEOUT

A. Section 260500 - Electrical General Requirements

B. Submit manufacturer's operation and maintenance instructions for each product.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.08 EXTRA PRODUCTS

A. Section 260500 - Contract Closeout.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish two replacement lamps for each size HID lamp type and LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Furnish Products as scheduled. Refer to Section 260500 for substitutions and product options.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.02 LAMPS

A. LAMPS: shall be provided for all lighting fixtures in accordance with the lighting fixtures schedule on the drawings. Unless noted otherwise fluorescent lamps shall be 3000°K "energy saving type". All lamps shall be new at time of final inspection and shall be manufactured by one of the following:

1. General Electric

2. Venture Lighting International

3. Phillips

4. Osram-Sylvania

B. Lamp Types: As specified for luminaire. Refer to Section 260500 for substitutions and product options.

2.03 FLUORESCENT BALLASTS

A. Fluorescent Ballasts: All ballasts shall be electronic type as scheduled on the drawings and shall comply with the following:

1. Fluorescent electronic ballasts: Shall comply with FCC rules and regulations part 18 concerning the generation of both EMI (electromagnetic interference) and RFI (radio frequency interference). Shall be Class "A" sound rated and UL class "P" thermally protected and shall be tested per ETL format. The

ballast shall withstand input power line transients as defined in ANSI C62.41. The ballast shall tolerate a line voltage variation of +/-10%, shall have a power factor of 95% or higher and the lamp crest factor shall measure 1.7 or less for rapid start ballasts and 1.85 or less for instant start ballasts. The total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current. The ballast shall operate at 20Khz or higher and shall operate standard lamps at 50 degrees F and energy saving lamps at 60 degrees F. Ballast case temperature shall not exceed 25 degrees C rise above a 40 degrees C ambient temperature. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of mis-wiring. The electronic ballast shall be warranted against defects in material and workmanship for three years. The warranty shall include either a $15 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.

2. Emergency Ballasts to provide emergency lighting when power fails to fixture, Bodine ballasts shall be provided for fixtures as scheduled and located on drawings. Ballasts shall light all designated fixture lamps at 5-% of nominal light output.

3. Dual Technology Ceiling Mounted Occupancy Sensors: Install a dual technology occupancy sensor # Omni-DT1000 with MP-120A or MP-277A power pack as manufactured by Mytech or equal of Wattstopper or Novitas as shown on the drawings. Configuration shall be as detailed on drawings. The sensor shall comply with the following specifications:

   a. Dual-element puroelectric sensor, with single-pole, double throw isolated relay.

   b. ASIC for reliability, immunity to RFI & EMI.

   c. Adjustable digital time-delay 15 seconds to 30 minutes.

   d. Shall be compatible of installing up to 3 units per power pack.

   e. UL listed with 5 year warranty.

   f. The power supply shall comply with the following specifications:

   g. Self contained transformer and relay with 24 VDC secondary voltage at an output of 100mA.

   h. Shall be capable of switching 20 amps of electrical load.

   i. Shall be UL listed with 5 year Warranty. Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.04 LED LUMINAIRE WARRANTY

A. Provide a written 5-year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

1. Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

2. Material warranty must include:

   a. All drivers.

   b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

B. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

2.05 PROVIDE LUMINAIRE USEFUL LIFE CERTIFICATE

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

2.06 LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.07 LED LUMINAIRES

Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires.

LED luminaires must meet the minimum requirements in the following table:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER – 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

LED luminaires must also meet the following minimum requirements:

A. Luminaires must have a minimum 5-year manufacturer's warranty.

B. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.

C. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

D. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.

2.08 FLUORESCENT LUMINAIRES

UL 1598. Provide linear and compact fluorescent luminaires complete with housing, ballast and light source. All fluorescent luminaires must be equipped with electronic ballasts.

2.09 HIGH INTENSITY DISCHARGE (HID) LUMINAIRES

UL 1598. Provide HID luminaires complete with housing, ballast and light source.

2.10 INDUCTION LUMINAIRES

UL 1598. Provide induction luminaires complete with housing, generator and light source.

2.11 LUMINAIRES FOR HAZARDOUS LOCATIONS

In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.12 LED DRIVERS

NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

A. Output power (watts)and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

B. Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.

C. Current draw Total Harmonic Distortion (THD) of less than 20 percent.

D. Class A sound rating.

E. Operable at input voltage of 120-277 volts at 60 hertz.

F. Minimum 5-year manufacturer's warranty.

G. RoHS compliant.

H. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.

I. UL listed for dry or damp locations typical of interior installations.

J. Non-dimmable, or fully-dimmable to 1% using 0-10V, or 3 wire, control as indicated in luminaire schedule and on drawings.

2.13 FLUORESCENT ELECTRONIC BALLASTS

NEMA ANSLG C82.11, UL 935, CEC Title 24. Fluorescent ballasts must not contain any magnetic core and coil components, and must meet the following requirements:

A. Provide with transient protection as recommended by IEEE C62.41.1 and IEEE C62.41.2.

B. Provide UL listed Class P, "A" sound rating, with minimum power factor rating of 0.98 and minimum ballast factor rating of 0.95.

C. Be designed for the wattage and type of light source provided in the luminaire specified, and have circuit diagrams and light source connection information printed on the exterior of the ballast housing.

D. Contain no PCB's and be RoHS compliant.

E. Be manufactured in an ISO 9001 certified facility.

F. Operate at a frequency greater than 20 kHz, and have a Lamp Current Crest Factor less than 1.7.

G. Have a light regulation of plus or minus 10 percent of lumen output when operating within a plus or minus 10 percent range of input voltage.

H. Have a full replacement warranty of five years from date of manufacture.

2.14 T8 PROGRAMMED-START FLUORESCENT BALLASTS

Provide programmed-start T8 electronic fluorescent ballasts with the following characteristics:

A. Total harmonic distortion (THD): Must be 20 percent (maximum).

B. Input wattage at 120/277 volts.

1. 29/28 watts (maximum) when operating one F32T8 light source
2. 55/54 watts (maximum) when operating two F32T8 light sources
3. 84/82 watts (maximum) when operating three F32T8 light sources
4. 109/107 watts (maximum) when operating four F32T8 light sources

C. Where indicated on project drawings, provide multi-light source luminaires with two or more ballasts to accomplish the switching scenario indicated.

1. A single ballast may be used to serve multiple luminaires if they are continuously mounted and factory manufactured for that installation with an integral wireway.

2.15 T5 (LONG TWIN TUBE) AND T5HO FLUORESCENT BALLASTS

A. Total harmonic distortion (THD): Not greater than 20 percent.

B. Input wattage:

(1) 45 watts (maximum) when operating one F40 T-5 light source

(2) 74 watts (maximum) when operating two F40 T-5 light sources

(3) 105 watts (maximum) when operating three F40 T-5 light sources

C. Provide three and four light source luminaires with two ballasts per luminaire where multilevel switching is indicated.

2.16 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type and wattage as indicated in luminaire schedule on project plans.

A. LED Light Sources
1. Correlated Color Temperature (CCT) of 3000 or 4000 degrees K as indicated.
2. Minimum Color Rendering Index (CRI) R9 value of 80.
3. High power, white light output utilizing phosphor conversion (PC) process or mixed system of colored LEDs, typically red, green and blue (RGB).
4. RoHS compliant.
5. Provide light source color consistency by utilizing a binning tolerance within a 3 step McAdam ellipse.

2.17 CONTROLS

A. Dual Technology Wall Mounted Occupancy Sensors: Spaces indicated on drawings shall be equipped with a dual technology occupancy sensor DT-100L as manufacturer by Wattstopper. The sensors shall be connected to a power supply as specified above. The sensor shall comply with the following specifications:

1. Shall utilize PIR and Ultrasonic technologies with an adjustable integrated light level sensor for 2.5 to 430 foot-candles. The output shall be a single-pole, double-throw isolated relay.
2. Shall utilize 40Khz +/- .006% ultrasonic frequency.
3. Shall provide an adjustable time delay of 15 seconds to 15 minutes and an LED indicator for both technologies.
4. Shall provide adjustable sensitivities, and shall be capable of installing two units per power pack.
5. Shall be UL listed with a 5 year warranty.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Support luminaires independent of ceiling grid, if layin type ceilings or concealed spline ceilings ore used.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating. Conductors in wiring channels of fixtures mounted in rows shall be the same size as the circuit wiring supplying the rows.

C. Install all fluorescent fixtures straight and true with reference to adjacent walls.

D. Install all lighting fixtures, including those mounted in continuous rows, so that the weight of the fixture is supported either directly or indirectly by a sound and safe structural member of the building, using adequate number and type of fasteners to ensure a safe installation. Screwed fastenings and toggles through ceiling or wall material are not acceptable. Provide suitable connectors or collars to connect adjoining fixtures in continuous rows.

E. Do not support fixtures from roof deck. Provide unistrut channels spanning space between roof joists to support fixtures and outlets.

F. Fixtures mounted in lay-in grid ceilings shall have safety support wires to structural roof members as detailed for seismic restraint.

G. All single outlets shall be properly centered in each room. Where two or more outlets occur, they shall be spaced uniformly and in straight lines with each other.

H. Provide plaster frames and support channels around ceiling openings for recessed fixtures. Securely fasten to ceiling structural members.

I. Terminate circuits for recessed fixtures in an extension outlet box adjacent to ceiling opening and connect to fixtures with flexible steel conduit.

3.03 Where lighting fixtures and other electrical items are shown in conflict with locations and structural members and mechanical or other equipment, provide all required supports and wiring to clear the encroachment.

3.04 ADJUSTING

A. Section 260500 Contract Closeout

3.05 CLEANING

A. Section 260500 - Contract Closeout: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.06 DEMONSTRATION AND INSTRUCTIONS

A. Section 260500 - Contract Closeout - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.07 PROTECTION OF FINISHED WORK

A. Re-lamp or repair/replace luminaires that have failed at substantial completion.

END OF SECTION

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SECTION 26 56 00
AREA LIGHTING

PART 1 - GENERAL

1.01 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:

Exterior area, façade and landscape lighting.

1.02 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section 260500- Electrical General Requirements.

1.03 REFERENCES

(NEW)

1.04 SUBMITTALS FOR REVIEW

A. Section 260500 - Electrical General Requirements

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.05 SUBMITTALS FOR CLOSEOUT

A. Section 260500 - Electrical General Requirements

B. Submit manufacturer's operation and maintenance instructions for each product.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.08 EXTRA PRODUCTS

A. Section 260500 - Contract Closeout.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish

replacement lamps for each size HID lamp type and LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

1.09 REFERENCES

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 SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1089	(2013) Standard Specification for Spun Cast Prestressed Concrete Poles
ASTM G154	(2016) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2008; Effective Jan 2010) California's Energy

Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10 (2011; Errata 2015) IES Lighting Handbook

IES LM-79 (2008) Electrical and Photometric Measurements of Solid-State Lighting Products

IES LM-80 (2015) Measuring Lumen Maintenance of LED Light Sources

IES RP-16 (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering

IES RP-8 (2014) Roadway Lighting

IES TM-15 (2011) Luminaire Classification System for Outdoor Luminaires

IES TM-21 (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.41 (2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps

ANSI ANSLG C78.42 (2009; R 2016) For Electric Lamps: High-Pressure Sodium Lamps

ANSI C136.13 (2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles

ANSI C136.21 (2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires

ANSI C136.3 (2014) American National Standard for Roadway and Area Lighting Equipment

	Luminaire Attachments
ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
ANSI/NEMA C78.LL 1256	(2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA ANSLG C78.380	(2007) Electric Lamps - High Intensity Discharge Lamps, Method of Designation
NEMA ANSLG C78.44	(2008) For Electric Lamps - Double-Ended Metal Halide Lamps
NEMA ANSLG C82.11	(2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts
NEMA ANSLG C82.14	(2006) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts -- for Metal Halide Lamps
NEMA C136.10	(2010) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing
NEMA C136.20	(2012) American National Standard for Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles

NEMA C136.31	(2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration
NEMA C78.LL 3	(2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Industrial Control and Enclosure Systems
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)
NEMA WD 7	(2011; R 2016) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts
UL 1310	(2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units
UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 773	(1995; Reprint Jul 2015) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016) Standard for Nonindustrial Photoelectric Switches for Lighting Control
UL 8750	(2015; Reprint Nov 2016) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment
UL 935	(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts

1.10 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.11 LED LUMINAIRE WARRANTY

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

A. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

   1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
   2. Material warranty shall include:
      a. All power supply units (drivers).

      b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

B. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

1.13 ELECTRONIC BALLAST WARRANTY

Furnish the electronic ballasts manufacturer's warranty. The warranty period shall not be less than five (5) years from the date of manufacture. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed twelve (12) months, thereby permitting four (4) years of the five (5) year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Government facility.

The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Furnish Products as scheduled. Refer to Section 260500 for substitutions and product options.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.02 GENERAL REQUIREMENTS

A. Housings for luminaires shall be die cast, extruded, or fabricated aluminum. Fabricated aluminum housings shall have all seams and corners internally welded to resist weathering, moisture and dust.

B. Luminaires shall be rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

C. Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

D. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

Application	Luminaire Efficacy in Lumens per Watt
Exterior Pole/Arm-Mounted Area and Roadway Luminaires	65
Exterior Pole/Arm-Mounted Decorative Luminaires	65
Exterior Wall-Mounted Area Luminaires	60
Bollards	35
Parking Garage Luminaires	70

E. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

F. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

G. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

H. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

I. Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.

J. Lenses shall be constructed of clear or frosted tempered glass polycarbonate vandal-resistant lenses as indicated.

K. The wiring compartment on pole-mounted, street and area luminaires must be accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

L. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

M. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

2.03 LUMINAIRE LIGHT SOURCES

2.04 LED LIGHT SOURCES

A. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

1. Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

B. Color Rendering Index (CRI) shall be:

1. Greater than or equal to 70 for 4000 degrees K light sources.

C. Color Consistency:

1. Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.05 LUMINAIRE DRIVERS

A. LED POWER SUPPLY UNITS (DRIVERS)

B. UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

1. Minimum efficiency shall be 85 percent.
2. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.
3. Shall be rated to operate between ambient temperatures of minus minus 22 degrees F and 104 degrees F.
4. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.
5. Operating frequency shall be: 50 or 60 Hz.
6. Power Factor (PF) shall be greater than or equal to 0.90.
7. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.
8. Shall meet requirements of 47 CFR 15, Class B.
9. Shall be RoHS-compliant.
10. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.
11. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

12. Shall be dimmable, and compatible with a standard dimming control circuit of 0 - 10V or other approved dimming system.
13. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

2.06 LED LUMINAIRE SURGE PROTECTION

A. Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install luminaires as detailed on the drawings or to poles as directed.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating.

C. Install all fixtures straight and true with site equipment, sidewalks, etc.

3.03 ADJUSTING

A. Section 260500 Contract Closeout

3.04 CLEANING

A. Section 260500 - Contract Closeout: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Section 260500 - Contract Closeout - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp or repair luminaires that have failed at substantial completion.

3.07 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.08 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

END OF SECTION

SECTION 26 80 10
HVAC SYSTEMS CONTROL

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. For Pump Station 1, the PLC system shall control VF-1. Other HVAC related I/O and Control as indicated in drawings.
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.

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.

A. 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.

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 THWN 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.

EXECUTION

3.1 GROUNDING

B. Labeling: All control conductors shall be numerically labeled corresponding to the mechanical control systems record drawings.

C. 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.

D. 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 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

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.

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.

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 -

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, over all trenches in field or yard areas, all areas designated on the site plans and plan and profiles on the Contract Drawings, or in all areas that the CONTRACTOR intends to disturb during construction operations.

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. The stripped material shall be deposited in such locations as are acceptable to ENGINEER. Topsoil shall be placed over designated areas to be landscaped, and over all trench areas (outside of areas to receive crushed stone surface).

B. All areas to be hydroseeded shall have a minimum thickness of 4 inches of topsoil.

3.4 DISPOSAL

A. No open burning of combustible materials will be 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

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)

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. 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. CONTRACTOR shall not borrow materials from onsite, adjacent private, or public lands. 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.

2.2 CRUSHED ROCK

A. Crushed rock shall consist of crushed stone with fines meeting the following gradation:

Sieve Size (Square Opening)	Percent by Weight (Passing Screen)
3/4-inch	100
No. 4	50-78
No. 8	37-67
No. 40	13-35
No. 200	4-15
PI	4-12

2.3 #2 CRUSHED STONE

A. #2 crushed stone consists of washed crushed stone meeting the following gradation:

Sieve Size (Square Opening)	Percent by Weight (Passing Screen)
3-inch	100
2-1/2-inch	90-100
2-inch	35-70
1-1/2-inch	0-15
3/4-inch	0-5

2.4 EXECUTION

2.5 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.

2.6 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. Crushed rock surface shall include the placement of an 8-inch layer of crushed rock with fines in areas designated on the Contract Drawings.

E. 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. All embankment fill material shall be placed and compacted to 96% minimum Modified Proctor Density as determined by ASTM D1557.

F. Crushed rock surface shall be placed in no more than 8-inch loose lifts for heavy equipment, and 4-inch loose lifts for hand operated equipment. A minimum of 2 lifts shall be required for placement of the crushed rock surface. Crushed rock shall be placed and compacted to 95% minimum Modified Proctor Density as determined by ASTM D1557.

G. 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.

H. 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.

2.7 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.

B. Areas to be hydroseeded shall be kept 4-inches below finished grade in preparation for topsoil placement and hydroseeding.

- END OF SECTION -

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SECTION 31 22 16
FINE GRADING & HYDROSEEDING

PART 1 GENERAL

1.1 SUMMARY

A. The Work includes, but is not limited to, performing fine grading work required for landscaping restoration and hydroseeding placement.

B. To improve the likelihood of successfully plant growth and avoid the cost of addressing plant failure CONTRACTOR may elect to provide additional thickness of topsoil and temporary automatic sprinkler systems (for hydroseeding option).

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 31 11 00 Clearing, Grubbing, and Stripping
2. Section 31 22 00 Site Grading

1.3 SUBMITTALS

A. Irrigation System:

1. If applicable, submit documentation of the irrigation components to be used in the project.

B. Hydroseeding:

1. Submit seed supplier’s qualifications.
2. Submit seed mix.
3. Submit installer’s qualifications.

C. Erosion control matting:

1. Submit documentation for erosion control matting documentation compliance with the specifications.

D. Maintenance:

1. Prepare and submit a maintenance plan identifying the work to be performed, the individual responsible for maintenance, and contact information for the responsible person.

1.4 QUALITY ASSURANCE

A. Pre-Installation Meetings - Participate in pre-installation meetings specified in previous sections.

B. Do not make substitutions.

1.5 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Provide certificate of compliance from authority having jurisdiction indicating acceptance of fertilizer and herbicide mixture.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of seeded or sod areas up to the end of warranty. Maintenance services includes confirming irrigation systems are functional, repairing irrigation systems, reseeding, and repairing eroded areas.

PART 2 PRODUCTS

2.1 TOPSOIL

A. Topsoil shall be native topsoil as stripped during clearing, grubbing, and stripping operations per Section 31 11 00.

2.2 SEED

A. Provide fresh, clean, new crop seed complying with tolerance for purity and germination established by Official Seed Analysis of North America. Provide proof of grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed. Seed blend shall be **Lehi Native Restoration Seed Mix as supplied by Granite Seed and Erosion Control** with the following seed mix:

Species	**%**
Slender wheatgrass	15
Western wheatgrass	17.5
Bluebunch wheatgrass	16.25
Sheep fescue	3.5
Sandberg bluegrass	2.75
Indian ricegrass	10
Rubber rabbit brush	5
Western sage	5
Blanket flower	5
Blue flax	10
California poppy	10

B. Purchase seeds which bear this season's certification of weight, purity, and germination from a reputable seed company.

C. Seeding rate shall be a minimum of 20 lbs per acre.

2.3 EROSION CONTROL BLANKETS

A. Erosion control matting shall be erosion control blankets (ECB) which will provide temporary, biodegradable cover material to reduce slope erosion, enhance vegetation germination and growth, and minimize germination of weeds.

B. ECBs shall be provided in rolls and wrapped with a suitable material to protect against moisture intrusion and extended ultraviolet exposure prior to placement. Each roll shall be labeled with a date code for identification.

C. ECBs shall consist of a seed free aspen curled wood excelsior with 80% of the wood fibers equal to or greater than six inches in length. The fiber count shall be a minimum of 7,000 per square yard with a mass of 0.73 lbs/yd.

D. The top and bottom of the ECB shall have green polypropylene netting containing oxo-biodegrader and UV additives. The net openings shall be 1.0-inch x 2.0-inch maximum.

E. Erosion control blankets performance capabilities shall meet ASTM D 6459 and AST D 6460.

F. Staples shall have a minimum length of six inches with a U-shaped top.

G. ECBs shall be **Curlex I Erosion Control Blanket.**

2.4 TEMPORARY AUTOMATIC SPRINKLING SYSTEMS

A. Design Requirements

1. Contractor shall submit an irrigation design prepared by a Landscape Architect or Certified Irrigation System Designer.
2. The irrigation design shall include the following elements:
   a. System to have automatic controller and control valves.
   b. Filter when using secondary water.
   c. Backflow preventer when using culinary water.
   d. Low Precipitation Sprinkler Heads.
   e. Device to raise the head to 20 inches minimum above grade.
   f. Sprinkler head spacing no further than 120% of coverage (30’ heads spaced no further than 36’).
3. Irrigation systems shall be automatically operated.
4. Irrigation systems shall be designed and installed by a certified irrigation contractor.

B. Temporary automated sprinkling systems are not required for hydroseed installations but may be installed at CONTRACTOR’S option to facility performance of hydroseeding.

PART 3 EXECUTION

3.1 PREPARTION

A. Protection

1. Prepare and take care at work to avoid conditions which will create hazards. Post signs or barriers as required.
2. Provide adequate means for protection from damage through excessive erosion, flooding, heavy rains, Etc. Repair or replace damaged areas.

B. Surface Preparation

1. Do not commence work of this Section until site grading tolerances are met.
2. Seven days maximum prior to seeding:

a. Loosen area 4 inches deep, dampen thoroughly, and cultivate to properly break up clods and lumps.
b. If active weeds are present Contractor shall remove the weeds by grubbing the site. Weed plant material shall be physically removed from the site.
c. Rake area to remove clods, rocks, weeds, roots, and debris.
d. Grade and shape area to receive seed to bring surface to true uniform planes free from irregularities and to provide drainage and proper slope to catch basins.
e. After areas have been prepared, take no heavy objects over them except lawn rollers.
f. Rake or scarify and cut or fill irregularities that develop as required until area is true and uniform, free from lumps, depressions, and irregularities.
g. If the site has been allowed to lay dormant for more than two months after rough grading Contractor shall apply a non-selective herbicide to plants growing on the site. Apply applying herbicide Contractor shall wait two-three weeks before grubbing the site.

C. 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 ENGINEER.

3.2 GRADING PERFORMANCE

A. Grading Tolerances:

1. Maximum variation from required grades shall be 1/10 of one foot.

2. To allow for final finish grades of hydroseeding, sub-grade elevations in landscape areas, before placing topsoil are 4-inches below finished grade.

B. 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.

3.3 INSTALLATION

A. Install 4” depth of approved topsoil.

B. One Step Hydroseeding – After topsoil is placed and areas are graded, hydroseed with adequate equipment at time when little or no wind is blowing. Perform operation within the following dates: March 1 to May 1 and October 1 to November 1. Hydroseeding shall consist of preparing the seed mixture at a rate of 40 pounds per acre, fertilizer at a minimum rate of 50 pounds per acre, ‘silva-fiber’ at a rate of fourteen hundred pounds per acre of area. With water, agitate these components into a well mixed slurry substance and spray the mixture, under pressure, onto the prepared area.

C. After completion of One Step Hydroseeding place erosion control blanket.

1. Before installing erosion control blanket, the seedbed shall be inspected by the Owner's Representative to ensure it has been properly compacted and fine graded to remove any existing rills. It shall be free of obstructions, such as tree roots, projections such as stones, and any other foreign objects. The contractor shall proceed when satisfactory conditions are present, After the area has been properly shaped, seeded, fertilized and compacted, remove the erosion control blanket protective cover. Next, locate the start of the roll, making sure the roll is facing toward the area to be covered, and then roll out the product. The product shall be rolled out flat, even, and smooth without stretching the material then anchored to the sub-grade.
2. Erosion control blanket to be installed vertically on the slope; however, on short slopes it may be more practical to install horizontally across the width of the application when agreed upon by the Engineer prior to installation. If more than one width is required, simply abut the edges of the vertically installed blankets together and secure them with a common row of staples. Overlapping adjacent sides of erosion control blankets is not required when installed vertically on slopes. Horizontal joints shall be overlapped with adjacent blankets using a common row of staples with the adjoining blanket. Erosion control blankets shall be trenched at the head of the slope if the blanket cannot be extended three feet over the slope crest or if overland flow is anticipated from upslope areas.

3.4 CLEANING

A. Immediately clean up any soil or debris spilled onto pavement and dispose of all deleterious materials.

3.5 PROTECTION

A. Protect hydroseeded areas against traffic or other use immediately after seeding is completed by placing adequate warning signs and barricades.

B. Provide adequate protection of hydroseeded areas against trespassing, erosion, and damage of any kind. Remove this protection after seeded areas have been accepted by the ENINGEER.

3.6 ACCEPTANCE

A. Acceptance of restoration shall be based on a site inspection at the three separate stages defined below. A successful inspection is required at each of the three stages.

1. Germination: Germination is evidenced by plants which are alive and growing.
2. Maturity. Maturity is evidenced by plants which have produced seeds.
3. End of Landscape Restoration Warranty Period

B. Contractor may request a site inspection with ten days' notice to the City.

1. ACCEPTANCE STANDARD
   a. The Acceptance Standards for a successful inspection are:

1) Plants occupy more than 70% of the area.
2) Weeds occupy less than 10% of the area.
3) Bare spots shall not exceed ten (10) feet measured from edge of plant to edge of plant.

b. If the inspection is acceptable, the Contractor may proceed to the next stage. Contractor may schedule the next inspection when ready.
c. If the inspection fails, the Contractor shall address deficiencies at Contractor's cost. Another inspection at this milestone is required.
d. To confirm coverage, the City will use site inspections, aerial photography, and drone photography, at its election.

3.7 MAINTENANCE REQUIREMENTS FOR NATIVE AREA DURING WARRANTY PERIOD

A. Furnish service and maintenance of restored area for one year (warranty period). Note: warranty on the landscaping is separate from the infrastructure of the work.

B. During the warranty period the contractor shall provide the following services:

1. Inspect the site at least monthly.
2. Remove weeds as required to achieve the acceptance standard.
3. Remove garbage and litter from the site.

C. Maintain and repair the irrigation system. Temporary irrigation systems are not required, however the CONTRACTOR may elect to design and operate a temporary irrigation system. Once the end of the warranty period has been reached, the contractor shall remove all aboveground features of the temporary irrigation system.

1. Repair all breaks in the irrigation system immediately.
2. Perform weekly inspections and make needed adjustments.
3. Make seasonal adjustments to controllers as needed.

D. Repair erosion and settling damage.

3.8 WARRANTY

A. The warranty period will begin when a successful inspection has been achieved at the Maturity stage as defined in paragraph 3.6.

B. All landscaping will be covered by a warranty for a minimum of one year.

C. The warranty period will end with a successful site inspection as defined in paragraph 3.7.

- 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 92 10 Steel Pipe (AWWA C200)

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, 10 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 crushed rock or topsoil 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 10 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. 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

2. Waterline – Controlled Low-Strength Material (Flowable Fill):

   a. Flowable Fill shall be per APWA Section 03 31 05 – Controlled Low Strength Material.

C. Native Trench Backfill: Trench backfill may consist of native fill material meeting soils classification A-1 of AASHTO M 145, with a maximum particle size no greater than 4-inches in any dimension and shall be capable of meeting the compaction requirements. Trench backfill shall be non-plastic. Trench backfill shall be 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.

D. Imported Granular Trench Backfill: At the direction of the OWNER where native materials are unable to achieve satisfactory compaction or meet the required soils classification, imported granular trench backfill shall be used and shall consist of imported materials meeting soils classification A-1 of AASHTO M 145 and shall be non-plastic. Maximum particle size for backfill shall be no greater than 6 inches. Imported granular trench backfill shall be capable of meeting the compaction requirements.

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 Backfill material as specified.

1. Trench backfill in areas to receive crushed rock surface shall consist of backfilling the trench from above the pipe zone up to underneath the noted recommended depth for untreated base course and crushed rock surface 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 4-inches below finished grade with Trench Backfill material compacted to 95 percent of maximum density (ASTM D-1557). Backfill from 4-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 4-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 8-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, appliance

D. es, and equipment to maintain all excavations free from water during construction.

E. 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.

F. CONTRACTOR shall be responsible to obtain General Construction Dewatering discharge permits, if required.

G. CONTRACTOR shall install and operate the dewatering system so as to not cause damage or endanger adjacent structures or property.

H. 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.

I. 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.

J. 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.

K. 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 22 00 Site Grading
7. Section 31 23 15 Excavation and Backfill for Buried Pipelines
8. 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 backfill materials.

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. Report Atterberg limits with soil classification and sieve analysis.

2.3 FLOOR SLAB FILL (Upper 4 inches)

A. Material shall be imported non-expansive granular soil 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 FLOOR SLAB

A. Floor slab support material shall meet the structural fill material requirements as defined in paragraph 2.2.

2.5 1" WASHED ROCK

A. 1" 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
1-inch	95-100
3/4-inch	40-75
1/2-inch	15-35
3/8-inch	0-15
No. 4	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.

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 95% 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% 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. Contractor shall ensure that tests are 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.

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SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers furnishing and placing the loose riprap materials in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the drawings and/or as directed by the 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 31 05 19 Geosynthetics

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. ASTM C-127 Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
2. ASTM C-535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Testing certificates shall be submitted prior to acceptance of the rock source to verify the conformity for abrasion resistance or compressive strength to the requirements of this Section.

1.5 STORAGE OF MATERIALS

A. Materials shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials.

PART 2 PRODUCTS

2.1 LOOSE RIPRAP

A. Riprap shall consist of quarry stone which is sound and durable against disintegration under conditions to be met in handling and placing, and is hard and tenacious and otherwise of suitable quality to ensure permanency in the specified kind of work.

B. Riprap sources shall be approved by the ENGINEER prior to use. Concrete masonry or concrete pavement may not be used for riprap. Riprap shall be well graded with additional gradation requirements for riprap as follows:

LOOSE RIPRAP GRADATIONS

Riprap Designation	% Smaller Than Given Size By Weight	(Inches)	D_{50}** (Inches)
RIPRAP D50 = 6"	70-100	12	6
	50-70	9	
	35-50	6	
	2-10	2	
RIPRAP D50 = 12"	70-100	21	12
	50-70	18	
	35-50	12	
	2-10	4	
RIPRAP D50 = 24"	70-100	42	24
	50-70	30	
	35-50	24	
	2-10	12	

** D_{50} = Nominal particle size

C. All stone shall be angular (no rounded rock will be permitted), each piece having its greatest dimensions not greater than three times its least dimensions. All stone shall conform to the following test requirements of the American Society for Testing and Materials Standards:

	Requirements	**ASTM Standard**
Specific Gravity (min)	2.6	C 127
Los Angeles Abrasion, (max %)	40	C 535

D. The Contractor shall be responsible for obtaining (by selective mining, crushing, screening, or some other method) loose riprap that will meet the specified material requirements.

2.2 GEOSYNTHETIC (FILTER FABRIC)

A. Filter Fabric shall be non-woven and shall conform to the requirements of Section 31 05 19 – Geosynthetics.

PART 3 EXECUTION

3.1 LOOSE RIPRAP

A. Prior to placement of loose riprap, the subgrade shall be graded to the lines and grades shown on the drawings.

B. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and objectionable material.

C. Where filter fabric is placed under the riprap, the fabric shall be overlapped a minimum of 2-feet at all joints. Upstream sheets shall overlap downstream sheets. The fabric shall be anchored using trenches or aprons at the crest or toe of the slope. Fabric exposed to sunlight longer than 7 days shall be removed and replaced.

D. Riprap shall generally be placed starting at the lowest elevations and working upward. Riprap shall be placed to the minimum thickness designated on the drawings and shall be positioned in such a manner that will provide uniform distribution of the various sizes of stone and produce a well-keyed mass of rock with the least practical amount of void space. The surface shall be leveled as necessary, to produce a reasonably uniform appearance and the required thickness.

E. Where riprap is placed over a filter fabric, the riprap shall be placed so as to avoid damage to the fabric.

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SECTION 32 11 23
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 Contract 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).

PART 2 PRODUCTS

2.1 MATERIALS

A. Untreated Base Course: Untreated Base Course Materials shall meet the APWA Specifications for Grade 1 as shown in Table 32 11 23-1.

TABLE 32 11 23-1

SIEVE SIZE	GRADE 1 GRADATION (PERCENT PASSING)
1 1/2 inch	-
1 inch	100
3/4 inch	-
1/2 inch	79 - 91
3/8 inch	-
No. 4	49 - 61
No. 16	27 - 35
No. 200	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.

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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.

B. All piping, fittings, gaskets, couplings, service saddles, and linings shall be NSF 61 certified for use with drinking water systems.

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 Contract 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.

E. Lining applicator certification to apply Ceramapure PL90 lining per NSF 61 requirements. (See section 09 90 00 for more information.)

F. NSF 61 documentation for all products specified herein.

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 61) and must bear the logo "NSF-pw" or "NSF-61" indicating such certification. Pipe thickness rating shall be Class 53 or pressure class 350 as indicated on the Contract Drawings. The pipe shall be provided with rubber gaskets, specials, and fittings as required.

B. Buried Ductile Iron Pipe shall be encased in 8 mil (minimum), Group 2, Class C polyethylene (black for potable water and magenta for irrigation), 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 certified to 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.

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) or Series 3100P by Star Pipe Products (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 and shall be NSF 61 certified.

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 by the same manufacturer as the coupling. Grooving tools shall be from the same manufacturer as the grooved components.

2.5 DISMANTLING JOINT

A. Provide dismantling joints were shown on the Contract Drawings. CONTRACTOR will not be allowed to substitute any other type of dismantling joint unless approved by ENGINEER. The coupling shall be rated for 275 psi working pressure. Couplings shall be NSF 61 certified.

B. Dismantling joint 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 joint 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 dismantling joints installed in piping systems rated for positive pressure, the joint shall be restrained with harness bolts or tie rods. Other means of restraining the joint 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. Dismantling joints shall be **Model DJ400 by Romac**, or approved equal.

2.6 SERVICE SADDLE

A. Service saddles for use with ductile iron pipe shall be double strap nylon coated ductile iron type with dual steel straps. Service saddles shall be NSF 61 certified. Service saddles shall be rated up to 350 psi.

B. Casting shall conform to ASTM A536 Grade 65-45-12. Straps shall be AISI C1010 or C1018 electrogalvanized steel. Gaskets shall be NBR or EPDM. Coating shall be fusion bonded black nylon 10-14 mils thick or fusion-bonded epoxy.

C. Service saddles shall be **Model 202NU by Romac or F202 by Ford Meter Box Co**., no approved equal.

2.7 GASKETS

A. Gaskets for flanged joints shall be 1/8-inch thick SBR and shall be **Ring Flange-Tyte or Flange-Tyte II by U.S. Pipe**, no approved equal. Flange gaksets shall be rated for a minimum working pressure of 250 psi and shall be NSF 61 certified.

B. Gaskets for MJ or push-on joints shall be supplied by the pipe and fitting manufactures and shall be specific to the type of joint being provided. Gaskets shall be rated for a minimum working pressure of 250 psi and shall be NSF 61 certified.

2.8 BOLTS AND NUTS

A. Bolts and nuts shall be rated for the system working pressure with a minimum safety factor of three.

B. Flange Bolts:

1. Buried or Encased Flanges: Bolts shall have ASME B1.1, Class 2A threads, and be manufactured of alloy steel meeting the requirements of ASTM A193, Grade B7 and conform to ASME B18.2.1, and nuts shall have Class 2A fit, square or hex heavy dimensions in accordance with ASME B18.2.2, and be manufactured of carbon steel meeting the requirements of ASTM A194, Grade 2H heavy hex. Bolts and nuts shall be zinc coated. All buried bolts and nuts shall be grease coated and polyethylene encased per Paragraph 2.2.
2. Exposed Flanges: Bolts shall have ASME B1.1, Class 2A threads, and be manufactured of Type 316 Stainless-Steel meeting the requirements of ASTM A193, Grade B8M and conform to ASME B18.2.1, and nuts shall have Class 2A fit, square or hex heavy dimensions in accordance with ASME B18.2.2, and be manufactured of Type 316 Stainless-Steel meeting the requirements of ASTM A194, Grade 8B heavy hex.

C. Connection T-bolts for mechanical joint (MJ) fittings shall be Cor-Ten high strength, low alloy steel conforming to AWWA C111. All buried bolts and nuts shall be grease coated and polyethylene encased per Paragraph 2.2.

2.9 PIPE AND FITTING LININGS

A. All buried 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.

B. All exposed piping and fittings in the pump station shall be ceramic epoxy-lined as specified in Section 09 90 00 – Painting and Finishes. Pipe to be painted shall not have asphalt emulsion coating. Coating applicator shall be certified for application of Ceramapure PL90.

2.10 PIPE COATINGS

A. The exterior of buried pipe and fittings shall be an asphaltic coating approximately one-mil thick.

B. 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.

2.11 THRUST RESTRAINTS

A. Joint restraints shall be provided for all bends, fittings, and valves regardless of pipe size or location.

B. Pipe joint restraints shall be used where shown on the Contract Drawings. Pipe joint restraints may be integral joint restraint system like **TR Flex piping system by US Pipe (or approved equal),** exterior harness system like **Series 3100P by Star Pipe Products (or approved equal),** or exterior restraint device like **Megalug system by EBAA Iron (or approved equal)**. Maintain joint deflection within allowable tolerance as defined by restraint manufacturer. Gaskets supplied with restraint systems shall be NSF 61 certified.

C. Restrained joints shall be suitable for 250 psi test pressures.

2.12 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 "CAUTION IRRIGATION LINE BELOW" as applicable, or similar wording approved by ENGINEER. Safety tape shall be **MagnaTec by Empire Level Mfg Corp**, or approved equal.

2.13 TRACER WIRE

A. All piping (including service lines) shall be installed with #14 UF-G direct bury blue 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 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.

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 C 600. 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. All buried Ductile Iron fittings and valves shall be completely coated with food grade grease and shall be encased with polyethylene wrap and installed in conformance with AWWA C105 standards. All seams in the polyethylene encasement shall be taped 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 workday or period of suspension.

N. Safety tracer tape shall be installed 12-inches above the pipe along the entire length of pipeline.

O. Tracer wire shall be brought up at valve boxes as shown on the Drawings. 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 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.

3.3 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.

3.4 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.

3.5 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. Suction Piping (from existing pipeline connections to the pump cans)
   a. Piping 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 275 or 250 psi as applicable, and the minimum pressure at the high point in the segment shall be no less than 20 psi from the high pressure.
2. Discharge Piping (from pump discharge to end of transmission mains)
   a. Pipe shall be tested at a static pressure of 275 psi (drinking water system) and 250 psi (pressurized irrigation system) 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 275 or 250 psi as applicable, and the minimum pressure at the high point in the segment shall be no less than 20 psi from the high pressure.
3. 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.

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.

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 Contract 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)

3.6 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

3.7 PAINTING

A. All exposed piping shall be painted as specified in Section 09 90 00 – Painting and Finishes.

- END OF SECTION –

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 D1785 as modified herein.

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.

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.

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 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.

3.6 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

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SECTION 33 05 13
PRECAST CONCRETE MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall provide precast concrete manholes 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

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 A 1018	Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
5.	ASTM B 86	Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings
6.	ASTM C 150	Standard Specification for Portland Cement
7.	ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections
8.	ASTM C 497	Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
9.	ASTM C 857	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
10.	ASTM C 858	Standard Specification for Underground Precast Concrete Utility Structures
11.	ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
12.	ASTM C 923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

13. ASTM C 990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM C 1802 Standard Specification For Design, Testing, Manufacture, Selection, And Installation Of Horizontal Fabricated Metal Access Hatches For Utility, Water, And Wastewater Structures

C. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. AASHTO M 306 Standard Specification for Drainage, Sewer, Utility, and Related Castings

1.4 SUBMITTALS

A. CONTRACTOR shall provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate manhole 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 joint sealant materials.

1.5 QUALITY ASSURANCE

A. CONTRACTOR shall demonstrate that manholes 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.

C. Store precast concrete manholes 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 Contract Drawings to indicate its intended use.

PART 2 PRODUCTS

2.1 MANHOLES

A. Reinforced precast concrete manholes in accordance with ASTM C478 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 H-20 loading, unless noted otherwise. Design criteria shall be

as shown in the Contract Drawings. Manholes shall be manufactured by **Oldcastle Precast, Geneva Pipe and Precast**, or approved equal.

B. 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.

C. 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. Pipe connections shall be further sealed with a concrete field joint as shown on the Contract Drawings.

2.2 FRAMES AND COVERS

A. Manufacturers or approved equal shall be:

1. D & L Foundry and Supply, East Jordan, Neenah Foundry Co. Model Number shall be as shown on the Contract 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 "DRAIN" cast into cover.

2.3 SCREW ADJUSTABLE FRAMES AND COVERS

A. This paragraph defines the components and function of a Screw Adjustable System for cast iron manhole cover rings, inlet grate frames, or precast concrete inlets, and utility tops. Frames may be gray iron, ductile iron, or fabricated metals.

B. Design Requirements: The screw adjustment system shall be capable of supporting loads specified in AASHTO M 306, H-25, and HS-25 in the event of grout deterioration. The screw adjustment system shall be capable of adjusting the frame and cover, grate, or inlet to the designed final grade for both flat and sloping surfaces. Adjusting screws for square or rectangle precast tops shall not exceed spacing of 5 feet on center and shall be placed no less than 1-inch from any edge and no more than 12-inches from each corner.

C. The components of the Screw Adjustment System shall conform to the following requirements:

1. Casting Assembly: AASHTO M 306 Certified; H-25 or “Traffic Rated”
2. Castings: Gray Iron conforms to ASTM A 48, Class 35B, or Ductile Iron conforms to ASTM A 536
3. Fabricated Grates or Hatches: Fabricated metals conforming to ASTM C 1802
4. Screws: Zinc Plated mild steel conforming to ASTM A 1018
5. Nuts: Zinc Alloy conforming to ASTM B 86, C41A
6. Non-Shrink Cementitious Grout: Per Section 03 60 00
7. The manufacturer shall be **RimRiser**, or approved equal.

2.4 COMPONENTS

A. Manhole 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. Steps shall be manufactured by **American Step Company, Inc., M.A. Industries**, or approved equal.

2.5 BEDDING AND DRAINAGE ROCK

A. Bedding and Drainage Rock: 1-inch washed gravel and cobble drain rock.

B. Soil Backfill to Finish Grade: Trench Backfill Material as specified in Section 31 23 15 – Excavation and Backfill for Buried Pipelines.

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 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 INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast manholes bearing firmly and fully on bedding, compacted in accordance with Contract Drawings.

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 the manufacturer’s plant.

G. Verify manholes 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 or polyurethane sealant.

3.4 FRAME AND COVER INSTALLATION

A. Set frame and cover flush with finished grade.

B. Install concrete collar as shown on the Contract Drawings.

3.5 FIELD QUALITY CONTROL

A. Section 01 45 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Vertical Adjustment of Existing Manholes

1. Where required, adjust top elevation of manholes to finished grades shown on Contract 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 –

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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.

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 appurtenances for the drinking water system shall be NSF 61 certified. All appurtenances that are supplied identical for both the irrigation and the drinking water systems shall be NSF 61 certified.

E. Unless noted otherwise below or on the Contract Drawings, all system components shall be rated for the maximum system pressure or higher.

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 & Materials Testing
3.	Section 01 50 00	Temporary Construction Utilities and Environmental Controls
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 and Fittings
7.	Section 33 05 07.1	Polyvinyl Chloride (PVC) Pressure Pipe (ASTM D 1785)
8.	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. C 509 Resilient-Seated Gate Valves for Water Supply Service
3. C 512 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

E. NSF INTERNATIONAL (NSF)

1. 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 cut sheets on all mechanical appurtenances including fittings, valves, or other items shown on the Contract Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance, Cv factor, pressure rating, and dimensional data.

C. NSF 61 certification documentation.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Gate valves shall conform to the requirements of AWWA C509 or C515. 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 pump station. 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 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. Valves shall be pressure rated to a minimum of 250 psi working pressure.

F. Valves shall be manufactured by **Series A2360 by Mueller Co., Style 7000 by M&H, American Series 2500**, or approved equal.

2.2 BUTTERFLY VALVES

A. Butterfly valves shall conform to the following requirements:

1. Butterfly valves shall have a double offset disc design to reduce torque and seat wear, known as a double eccentric type. Valves shall be AWWA C504 Standard Class 150B. Valves shall be NSF 61 certified.
2. The valves shall have a heavy-duty ductile iron body conforming to ASTM A 536 65-45-12 with flanges fully faced and drilled per ANSI B16.1 Class 150B. Maximum flow velocity shall be less than 16 fps for cold water service. Working pressure rating shall be a minimum of 250 psi.
3. Disc body shall conform to ASTM A536 65-45-12 or 60-40-18 and shall be pinned used 2205 Duplex stainless steel pin. Disc seat shall be elastomeric and shall be secured to the disc with Type 316 stainless steel hardware. Disc seat shall be EPDM unless manufacturer recommends alternative which demonstrates better resistance to abrasion.
4. Body seat shall be 316L stainless steel and shall be applied through a high alloy weld double overlay process with a minimum thickness of 5mm.
5. The valve shall have a hand wheel operator and shall be geared to close slowly. Position indicator shall be provided with valve.
6. The valve shall a fusion bonded epoxy protective coating inside and outside with a minimum DFT of no less than 14 mils. Coating shall meet AWWA C550 and shall be non-toxic and impart no taste to water.

B. The valve shall be manufactured by **Av-Tek, VAG, AVK**, or approved equal.

2.3 BRASS **BALL VALVES**

A. Brass Ball Valves shall be full port opening brass, blow out proof stem design, adjustable stem packing, secondary O-ring stem seal, zinc plated steel handle with vinyl insulator. Valves shall be NSF 61 certified.

B. Brass ball valves shall be Apollo Series 77FLF-100, FNW X415, or approved equal.

2.4 INSULATING FLANGE KIT

A. Gasket materials shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline, and shall be NSF 61 certified.

B. Gaskets: Full-face Type F raised facer Trojan style insulating manufactured from Nema grade G-10 glass reinforced epoxy retainer with a Nitrile seal.

C. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).

D. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).

E. Steel Washers: Plated, hot-rolled steel, 1/8-inch thick.

F. Manufacturer shall be **APS**, or approved equal.

2.5 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” or “IRRIGATION” as applicable.

B. 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.

2.6 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.

2.7 DIAPHRAGM SEALS

A. Diaphragm seals shall be used with pressure gauges and pressure switches as shown on the drawings and shall have PDVF housing with PTFE diaphragms rated for 250 psi. Diaphragm seals shall be NSF 61 certified. Diaphragm seals shall be **Sentinel Diaphragm Seals by Blacoh Industries**.

2.8 BOOSTER PUMP CONTROL VALVES

A. Booster Pump Control Valves shall be designed to eliminate starting and stopping surges caused by the pump. The valve shall be equipped with a built in, lift type, check valve. The valve shall be hydraulically operated, diaphragm actuated, globe type valve. Valve stem, nut & spring shall be stainless steel and the valve body shall be cast steel conforming to ASTM A216, Grade WCB. Flanges shall be Class 300 and shall be rated for a working pressure of 285 psi. The vale trim (disc guide, seat & cover bearing) shall be stainless steel. The pilot system shall be stainless steel. The valve manufacturer shall provide a 3 year warranty on the valve and 1 year warranty on the electrical components.

B. The booster pump control valve shall be controlled by an externally mounted pilot control system with a four-way solenoid operated pilot. The solenoid shall be designed to operate on 120 Volt AC current and have a manual operator installed. The pilot system shall include a four-way solenoid pilot valve, opening and closing speed controls, shut off valves, strainers, and CVS-1 shuttle valve to provide the highest available operating pressure to the pilot system. The pilot system shall be equipped with a CV flow control valve to control opening and closing speeds.

C. The booster pump control valve shall have an adjustable dual limit switch assembly mounted on the main valve and connected to the main valve stem. It shall be actuated both by opening or closing of the valve and easily adjusted to operate at any point of the valve's travel. The limit switch shall be used to complete the pump on and off cycles. The actuating points of the limit switch shall be adjustable.

D. Booster pump control valves and their associated pilot system shall be NSF 61 certified. Submit certification which covers valve and pilot arrangement.

E. 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.

F. Booster pump control valves shall be **Model 60-11 by Cla-Val Company**, no approved equal.

2.9 SAMPLING TAPS

A. Sampling taps shall be smooth nosed brass with T-handles and shall be NSF 61 certified. Sampling taps shall be **Model 0874NL by Boshart**, or approved equal.

2.10 COMBINATION AIR VALVES

A. Combination air valves shall be single body, double orifice valves conforming to the requirements of AWWA C512. Valve shall exhaust large quantities of air during filling, shall open during draining or when negative pressures occur, and shall also release accumulated air from piping system. Valve body and cover shall be ductile iron. Valve float and internal parts shall be stainless steel with resilient seat. Valves shall be the size indicated on the Contract Drawings. Valves 4" and larger shall have 250 lb flanged end connection and valves 3" and less shall be threaded. Valves shall be pressure rated for a minimum of 300 psi service. Combination air valves shall be NSF 61 certified.

B. Valves attached to pump cans shall be equipped with low durometer seats.

C. Valves shall be **Series 140C by APCO (DeZURIK), Series 200C by Val-Matic**, or approved equal.

2.11 FLOW METER

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

2.12 PRESSURE TRANSMITTERS

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

2.13 PRESSURE SWITCHES

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

2.14 GUIDED LEVEL SENSORS

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 plans and in accordance with the manufacturer's written instructions.

- END OF SECTION -

SECTION 33 12 30
PUMP AND PUMP MOTOR

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish, deliver and install a short set vertical turbine pump, with multiple stages, and motor, integral suction barrel, above grade discharge head, and appurtenant work, complete and operable, as shown on the Contract Drawings.

B. The pump manufacturer shall be made responsible for furnishing the Work and for the coordination of design, assembly, testing, and installation of the Work. CONTRACTOR shall be responsible to OWNER for compliance with the requirements of each pump.

C. Where 2 or more pumps of the same type or size are required, provide pumps produced by the same manufacturer.

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 33 12 00 Mechanical Appurtenances
3. Section 33 13 00 Pipeline Testing and Disinfection
4. Lehi City Standards Chapter 8: Culinary and Irrigation Water Lines

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 B16.1 Gray Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 48 Standard Specification for Gray Iron Castings
3. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot- Dipped, Zinc-Coated, Welded and Seamless
4. ASTM A 108 Standard Specification for Steel Bars, Carbon and Alloy, Cold ` Finished
5. ASTM A 536 Standard Specification for Ductile Iron Castings
6. ASTM A 582 Standard Specification for Free-Machining Stainless Steel Bars
7. ASTM B 505 Standard Specification for Copper-Alloy Continuous Castings
8. ASTM B 584 Standard Specification for Copper Alloy Sand Castings General Applications

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 651 Standard for Disinfecting Water Mains
2. AWWA E 103 Standard for Horizontal and Vertical Line-Shaft Pumps

E. NSF INTERNATIONAL (NSF)

1. NSF 60 Drinking Water Treatment Chemicals
2. NSF 61 Drinking Water System Components – Health Components
3. NSF 372 Drinking Water System Components – Lead Content

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittals.

B. 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 the specified requirements. The following shall also be furnished with the submittal:

1. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the specified design point.
2. Discharge Head shop drawing showing material type, diameter, thickness, all applicable dimension, and appurtenances ports and connections; discharge nozzle size and location; and exterior coating and interior lining system.
3. Suction Can/Barrel shop drawing showing barrel material type, diameter, thickness, all dimensions; suction nozzle size and location; flow vanes material, thickness, size, and locations and demonstrate clearance between flow vanes and pump bowls; bolting hole pattern and sizes; and exterior coating and interior lining system.
4. Equipment manufacturer shall provide complete and detailed information regarding the installation of the pumps. Any installation requirements or operating conditions which the supplier or manufacturer considers to be critical to the safe and reliable operation of the pumps should be identified and described in detail.
5. Shop drawings submitted for review also shall include electrical diagrams, schematic control diagrams, and a detailed description of how the control system is to function.
6. Submit performance curves at minimum speed, maximum speed, and two speeds equally spaced between the minimum and maximum speeds for each pump ..

C. Submit signed, dated, and certified factory test data for each pump which requires factory testing. Submit these data before shipment of equipment.

D. NSF 61 documentation for pumps specified herein.

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 by CONTRACTOR 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 and acceptance by OWNER. 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 FACTORY TESTING

A. Equipment shall be factory tested and inspected as specified hereinafter. All costs for the tests shall be borne by CONTRACTOR. Conduct the following tests on each indicated pump system:

1. Non-Witnessed Certified Factory Test
   a. Perform tests using the complete pump system to be furnished, including the project motor and variable speed drive. For pumps with motors smaller than 300 hp a shop motor may be used for testing. All testing shall be done a full speed and test results based upon calculations using infinity curves will not be acceptable.
   b. Testing of prototype models will not be accepted.
   c. Pumps shall meet the requirements of HI 14.6 Grad 1U.
   d. Conduct performance test and record on data sheets as defined by the Hydraulic Institute standards. Test each pump between maximum and minimum speed at 100 rpm increments. Submit pump curves showing head vs. flow, bhp, KVA, KW, and efficiency results.
   e. Mechanical Test: Submit certification signed by a senior official of the pump manufacturer that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.
   f. Submit test results to Engineer for review prior to delivery of the pumps to the Site.
2. Conduct a pump hydrostatic test.
3. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of this Section and re-test the pump until found satisfactory.

1.8 STRUCTURAL FREQUENCY ANALYSIS

A. In order to ensure that neither harmful nor damaging vibrations occur to the pump structure at any speed within the specified operating range, the following analysis shall be required:

1. Pump manufacturer shall perform a structural frequency analysis of the above ground structural components utilizing a FEA method to ensure that no structural

natural frequencies are excited to a degree that would cause measured vibration amplitudes at the top of the discharge head to exceed the requirements of ANSI/HI 9.6.4-2009. When deemed necessary by the experience of the manufacturer, the below ground structural components shall also be included in the analysis.

2. The FEA method should include the use of ProE/Mechanica or an equivalent software. All pump assembly components, including the motor, shall be represented as solid elements, and if idealizations are used in place of solid elements, then a complete description of method for the idealization shall be included in the report. The analysis shall also include all modes of interest and pictorially represent each mode shape. Modes of interest are defined as those structural frequencies that exist below 120% of the maximum operating speed. When significant modifications are required to lower the system's natural frequency, the pump structure's stresses and deflections shall also be reviewed. Analysis reports shall conclude acceptable operation at the analyzed operating speeds. The design critical frequency shall be at least 20% above or below the operating range of the pump.

B. Manufacturer to provide documentation of the analysis ensuring that the specified requirements have been met, and that documentation should be signed and stamped by the professionally licensed engineer who performed the analysis work.

C. When measured in the direction of maximum amplitude on the pump and motor bearing housings, shall not exceed limits given in the latest ANSI/HI nomograph for the applicable pump type.

PART 2 PRODUCTS

2.1 GENERAL

A. Compliance with the requirements below may necessitate modifications to the manufacturer’s standard equipment.

B. Unless otherwise noted, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or encroach on the service factor.

C. Provide each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer’s name and model number.

2.2 VERTICAL TURBINE PUMP

A. The pumps shall be of the vertical turbine type suitable for pumping drinking water or irrigation water and shall be in compliance with AWWA E103. All material, manufacturing, and performance standards for drinking water pumps shall be certified to NSF 60, NSF 61, and NSF 372 as applicable. NSF certification shall cover all components of pump assembly from suction casing to discharge head including, but not limited to, suction casing, bowls and impellers, discharge casing, column piping, couples, shafts, seals, and discharge head assembly. No materials of construction used in complete and operable pump assembly shall be submitted as NSF “compliant.”

B. Performance Requirements

1. Operating Conditions:

DESCRIPTION	Drinking Water Pump IDs *P-1, P-2, & P-3*	Irrigations Water Pump IDs P-4, P-5
Duty	Continuous	Continuous
Drive	Variable Speed	Variable Speed
Ambient Environment	Indoors	Indoors
Ambient Temperature (°F)	40 to 100	40 to 100
Ambient relative humidity (%)	20 to 80	20 to 80
Fluid Temperature (°F)	35 to 60	35 to 60
Fluid pH range	6 to 9	6 to 9
Project site elevation (ft above msl)	4,922	4,912
NPSH Available (ft)	30	30
NPSH Required	18	14
Pump Lubrication	Product	Product
Maximum shutoff head (ft)	928	630
Design flow capacity (gpm)	2,500	1,300
Design flow total dynamic head (ft)	480	455
Pump Setting Depth (ft) (Bottom of Discharge Head to Suction Bell)	15’-3”	27’-4”
Nominal Operating Speed (rpm)	1,800	1,800
Design flow minimum efficiency (%)	82	83
Maximum Bowl Diameter (inches)	14.2	11.63
Column Size (diameter in inches)	10	8
Minimum Shaft Size (inches)	2-3/16	1-11/16
Minimum Pump Can Size (inches)	24	24
Pump Model Number	National H14LC	National K12HC
Maximum Number of Pump Bowls for Designated Barrel Length	8	7

DESCRIPTION	Drinking Water Pump IDs *P-1, P-2, & P-3*	Irrigations Water Pump IDs P-4, P-5
Maximum Motor Horsepower (hp)	400	200
Utility Power (Phase, Volts, Hertz)	3, 460, 60	3, 460, 60

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 the table above 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 rates and total dynamic heads indicated in the table above.
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.

C. Vertical Turbine Pump Components

1. Pumps
   a. The vertical turbine pump shall be as manufactured by **National Pump Company, Flowserve,** or approved equal, and shall be a multi stage bowl assembly.
   b. Unless otherwise stated herein, the pump shall in all respects conform to the AWWA E103 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) shall have a minimum working pressure of 275 psi 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 motor 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 and be machined to match the pump barrel and be capable of withstanding the system inlet pressure without leaking. CONTRACTOR shall modify the pump base dimensions on the drawings to match supplied head.
   b. The pump manufacturer shall include the method of adjusting the pump impellers at the top of the head shaft. This method shall provide a positive locking device.
   c. CONTRACTOR shall be responsible for ensuring that the discharge head is structurally and mechanically adequate for the provided and installed pump configuration.
3. Pump Can

a. The pumps shall be provided with a pump can of the same materials as the discharge head. The pump can shall be capable of containing the maximum suction pressure applied to the suction connection. The bottom of the suction barrel shall be supplied with a welded suction pot. CONTRACTOR may provide a bottom steel plate welded to the bottom of the pump can with bolt holes to plumb and level the barrel. Provide anti-vortex vanes on sides and bottom as indicated on the Contract Drawings.
b. The pump can shall be provided with a suction flange connection for a minimum working pressure of 150 psi and shall be sized to match the specified system.
c. The can shall be equipped with a soleplate which shall be machined and tapped to match the discharge head base flange. The soleplate shall be drilled to allow the can to be secured in place with anchor bolts. Soleplate shall be supplied with proper gasket and bolting for application to seal between the soleplate and the discharge head flange and shall be electrically isolated as shown on the Contract Drawings. Gasket materials shall be NSF 61 certified and shall be cut in an NSF approved factory.

4. Packing Boxes
   a. The pump shall have a single cartridge mechanical seal with housing which bolts to the head with an “O” ring seal. Mechanical seals shall **be Flex-A-Seal RB3**, no approved equal. The housing shall have a lower bronze throttle bushing. The housing seal chamber shall accommodate a single sleeved balanced mechanical seal suitable for the maximum pressure developed by the pump and temperature of 100-degree F maximum. Seal materials shall be silicon carbide by silicon carbide suitable for irrigation water. A balanced seal shall be mounted on a shaft sleeve. The shaft supplied shall be a one-piece bowl, line, and head shaft where practical of 416 stainless steel material.
5. Column Assembly
   a. The column assembly shall be supplied with ASTM A53 Grade B steel pipe flanged with fabricated steel or removable ductile iron A536 Grade 60-40-18 bearing retainer equipped with suitable lineshaft bearings for the application. Column bearing spacing shall be such that shaft first critical frequency shall be safely above or below the operating resonant frequency. Column assembly shall be NSF 61 certified.
6. 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 above. 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 1-1/2 times the shut-off head, whichever is greater.
   b. The impellers shall be lead-free bronze, enclosed type, and shall be statically balanced, and shall be fastened securely to the impeller shaft with taper split bushings of steel. 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 17-4 stainless steel with the impeller wear ring having a hardness of at least 50 units less or more than the bowl wear ring.
7. Pump Shaft
   a. The pump shaft shall be of A582 Grade 416 Stainless Steel turned, ground and polished. It shall be supported by lead-free bronze bearings above and below

each impeller. The suction case bearing shall be grease lubricated and protected by a lead-free bronze sand collar. The size of the shaft shall be no less than that determined by AWWA E103.

2.3 MOTORS

A. Pump motors shall be a vertical solid shaft with adjustable spacer coupling, premium efficiency, inverter duty electric motor, and shall be sized as noted in the table above. They shall have a non-reverse ratchet, P-base, squirrel cage induction design. Motor shall have 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 50-110 degrees Fahrenheit.

B. Pump motors shall be provided with vibration switches with ratings of 120 BVAC, 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. The 200 hp motors shall be equipped with temperature switches, NEMA MG 1-12.57, Type 2.

E. Thrust bearing shall be chosen to handle the continuous down-thrust as specified by the pump manufacturer with an AFMBA B-10 bearing life of 12,320 hours, an L-10 bearing life of 17,500 hours, and an L-50 bearing life of 61,600 hours. Provisions shall be made for momentary up-thrust equal to 30% of rated down-thrust. The thrust value shall be calculated at curve points 75% to 125% of specified, full speed, flow rate.

F. The motor shall be suitable for across-the-line starting, soft start, be inverter duty, and shall be capable of reduced-voltage starting.

G. Motors shall have factory installed shaft grounding rings for use with a VFD. 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.

H. The motor rating shall be such that at design nor any place along the curve will it be loaded beyond nameplate rating of motor. Service factor for motor shall not be utilized.

I. 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.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install 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 suction barrel 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 suction barrel 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 approved equal.

3.3 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09 90 00 Painting and Finishes.

3.4 DISINFECTING

A. Source of Water

1. Contractor shall assume all responsibility to obtain the necessary water supplies for disinfection of the pumping system.

3.5 TESTING PROCEDURE

1. Leakage and pressure testing must be completed prior to disinfection procedures.
2. All pump and water piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the AWWA C651.

3. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfite (NaHSO3) 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 approval of disinfection, Contractor shall flush the new system until the chlorine residual is a maximum of 0.3 ppm.
5. At the end of the disinfecting period, a bacteriological test will be performed by Owner to insure adequate disinfection and a second test will be taken at the end of an additional 24 hour period after the first test. If either of the tests 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 to 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.

C. Hydrostatic testing shall meet the requirements of this Section or the requirements provided in each individual pipeline Section, whichever is more stringent.

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 (AWWA C200)

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 be conducted as defined within Section 33 05 05 Ductile Iron Pipe.

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 OWNER. OWNER 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 92 10
STEEL PIPE (AWWA C200)

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall provide fabrication and installation of steel pipe complete and in place, in accordance with AWWA C200 and as modified herein.

B. A single pipe manufacturer shall be made responsible for furnishing steel pipe and appurtenances such as bolts and gaskets.

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 C210 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 215 Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines)
10. AWWA C 216 Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings
11. AWWA C 219 Bolted, Sleeve-Type Couplings for Plain-End Pipe
12. (AWWA C 222 Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings)
13. AWWA C 606 Standard for Grooved and Shouldered Joints
14. AWWA C 651 Standard for Disinfecting Water Mains
15. 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. NSF 61 documentation for all products specified herein.

C. Shop Drawings

1. Prepare and submit certified dimensional drawings consistent with the pipeline alignment and grade in the Contract Drawings, including all 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 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. Material lists and steel reinforcement schedules that describe materials to be utilized.
4. Line layout and marking diagrams which indicate the specific number of each pipe, the location of each pipe in the completed line compatible with requirements of AWWA M11. 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.
5. 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.

6. 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.
7. 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.
8. 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.
9. Manufacturer's written Quality Assurance/Control Program.

D. 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.

E. Performing and paying for sampling and testing necessary for certification are CONTRACTOR's responsibility.

F. 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.

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. 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 pipes 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.
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 and field welding 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 shall be under the direction and management of one steel pipe manufacturer only. The responsibility of the Main Pipe Manufacturer shall include at a minimum:

1. Verify pipes 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 pipes. 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 shall conform to AWWA C222 and AWWA C210 per Section 09 90 00.

C. The pipes shall be of the diameter and class indicated and shall be provided complete with welded joints as indicated on the Drawings. Pipes shall 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.

D. Markings: The manufacturer shall legibly mark pipes in accordance with the laying schedule and marking diagram. Each pipe 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 number shall be located on the inside and outside area of pipes. Interior marking shall be in full conformance with NSF 61. Each pipe 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. Mark “Top Match Point” for compound bends per AWWA C 208.

E. Handling and Storage: The pipes 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 pipes shall be supported on padded skids, sand or earth berms free of rock exceeding 2-inches diameter, sandbags, or suitable means so that the pipe including coating and lining coating will not be damaged. Pipes 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.

F. CONTRACTOR shall replace or repair any pipes damaged at no additional cost to OWNER.

G. Strutting: Adequate strutting shall be provided on straight pipe so as to avoid damage to the pipes during handling, storage, hauling, and installation.

H. Laying Lengths: Maximum pipe laying lengths shall be 48-feet with shorter lengths provided as required to accommodate CONTRACTOR's operation.

I. Lining: The pipes shall have smooth, dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

J. 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.

K. Backfill with CLSM: Where not concrete-encased, all steel pipe shall be backfilled with Controlled Low Strength Material (CLSM) shall be the full depth of the pipe zone from 6 inches below to 12 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: Pipes 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: In accordance with Section 09 90 00 Painting and Finishes.

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 epoxy lined and polyurethane coated as per Section 09 90 00. Field lining will not be allowed.

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. Joints shall be flanged as shown on the Contract Drawings.

D. 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.

E. 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.

F. Flanges

1. Flanges shall be in accordance with AWWA C207 Class D for operating pressures operating pressures to 150 psi.
2. 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.
3. Flange Gaskets on the project shall be full faced, 1/8" thick, NSF 61 certified, and shall be **Stress Saver XP (NSF) by Garlock**, or approved equal.

G. Bolts and Nuts for Flanges

1. See Section 33 05 05 Ductile Iron Pipe for flange bolting requirements.

2.4

2.4 EXTERIOR COATING OF PIPE

A. Exterior Coating of Buried Piping shall be coated per Section 09 90 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Handling and Storage: Pipes shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall. Pipes 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. Pipes 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 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 for damage. CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.

E. Before placement of pipes 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 in the trench shall be closed during any interruption to the project.

F. Steel pipe shall be concrete-encased or backfilled with CLSM as shown on the Contract Drawing. Pipe 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. Installation Tolerances: Each section of pipe shall be laid in the order and position on the laying diagram and in accordance with the following:

1. Each section of pipe having a nominal diameter less than 48-inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus 1-inch vertical deviation.
2. Each section of pipe having nominal diameter 48-inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
4. After installation, pipes shall not show deflection greater than 3.75 percent for flexible-lined and flexible-coated or bare pipe. The allowable deflection shall be based on the design inside diameter.
5. CONTRACTOR shall not permit the pipeline to experience a differential settlement after welding of more than 1.5” over 300 feet.

H. For pipe backfilled with CLSM, struts shall be left in place until the CLSM backfill has obtained a minimum 7-day cure.

I. Cold Weather Protection: No pipe shall be installed upon 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. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

J. Flotation: At all times, means shall be provided to prevent the pipe from floating. Take necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. CONTRACTOR shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from materials and in a clean and sanitary condition.

K. 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 JOINT COATING AND LINING

A. General: The interior and exterior joint recesses shall be thoroughly wiped clean and water, loose scale, dirt, and other foreign material shall be removed from the inside surface of the pipe.

B. Coating Repair: Coating repair shall be in accordance with Section 09 90 00.

3.3 PRESSURE TESTING

A. Pressure testing and disposal of test water shall be in accordance with Section 33 05 05 Ductile Iron Pipe and 33 13 00 – Pipeline Testing and Disinfection.

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SECTION 40 05 13.33
BRASS PROCESS PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all brass 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 brass process pipe in accordance with ASTM B43.

C. All products specified herein such as brass piping, fittings, Teflon tape, and thread sealant shall be NSF 61 certified and NSF 372 low-lead certified for use with drinking water systems.

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 (Pipe Supports)
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. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. ASME B1.20.1 Pipe Threads, General Purpose
2. ASME B 16.15 Cast Bronze Threaded Fitting Class 125 & 250

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM B 43 Standard Specification for Seamless Red Brass Pipe, Standard Sizes

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. 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 NSF 61 and NSF 372 certification for all products specified herein.

PART 2 PRODUCTS

2.1 BRASS PIPE

A. Brass pipe shall conform to ASTM B43 and shall be extra strong (Schedule 80).

B. Brass pipe joints shall have NPT threaded ends. Threaded joints shall be joined with Teflon tape or thread sealant. Threads shall conform to ASME B1.20.1.

C. All brass pipe, fittings, thread sealant, and Teflon tape shall be NSF 61 or NSF 372 certified.

2.2 FITTINGS

A. Threaded fittings shall be in accordance with ASME B16.15 and shall be Class 250.

B. Brass fittings shall be NSF 61 or NSF 372 certified.

PART 3 EXECUTION

3.1 INSTALLATION

A. For buried pipelines, excavation and backfill of trenches and for appurtenances shall be in accordance with Section 31 23 15 - Excavation and Backfill for Buried Pipelines.

B. Above ground brass 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.

C. Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 05 45 00. 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. 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.

3.4 INSPECTION AND TESTING OF PIPELINE

A. Completed brass 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. Piping shall be tested in conjunction with pump station piping per Sections 33 05 05 and 33 13 00.

- END OF SECTION –

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SECTION 40 12 50
PRESSURE TRANSMITTER

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation 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 Instrumentation System, General

B. Section 40 20 00 – Instruments, General

PART 2 - PRODUCTS

2.1 PRESSURE TRANSMITTERS

A. Gauge Pressure Transmitters

1. Acceptable manufactures are:
   a. Emerson Rosemount 3051 Series
2. Power supply shall be 24VDC, powered from PLC panel power supply. Process connection shall be 1/2-inch female NPT flange adapter. Signal output shall be 4 to 20 mA.
3. Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Span shall be adjustable over a 6:1 or greater range. Over range capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inch over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column.

4. Transmitter shall be provided with the following adjustable range:

Adjustable range of transmitter, water column	Span specified in the instrument schedule, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

Higher ranges and spans shall be provided as specified in the instrument schedule. Transmitter for spans less than or equal to 25 psig shall be provided with one 1/2-inch flanged process connection and two 1/4-inch drain/vent ports, one plugged and one provided with bleed valve. Transmitter shall be provided with an evacuated sealed chamber and reference diaphragm shall be provided with a weatherproof, bug proof atmospheric vent. Transmitters for spans greater than 25 psig shall be similar except designed for gage pressure service, and overpressure rating shall be greater than the lesser of 2000 psig and 150 percent of maximum range.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

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 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 milli

amperes, 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 enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

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 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 shall 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.

2.3 Pressure Switches Low

a) Device identifications: See Section 40 20 00

b) 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.

c) Pressure switches shall have a contact rating of 10 amperes at 125 VAC.

d) Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.

e) Diaphragm seals shall be provided and included at the locations shown.

f) Automatic reset.

i) As manufactured by:

1) Mercoid.

2) Or approved equal.

B. The CONTRACTOR shall deliver to the OWNER all required spare parts. The spare parts shall not be used as replacement parts during system start-up or the guarantee period.

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 2 - PRODUCTS

2.1 PRESSURE INSTRUMENTATION

A. Seals

1. All pressure gauges shall be provided with seals. See Section 40 91 19.26.

2. Pressure gauges and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.

2.2 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, snubbers, 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 suction and discharge connection to all pumps.

2) On discharge connection from blowers and compressors.

3) On each side of pressure reducing valves.

4) In other locations as shown on the P&IDs and/or mechanical plans.

c. Vacuum gauges shall be provided whether or not shown on the plans:

1) On all supply side educator type chemical feeders.

2) In other locations as shown on the P&IDs and/or mechanical plans.

d. 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. Seals

a. Gauges attached to systems without particulates shall be equipped with seals. See Section 40 27 60.

4. Gauges general as manufactured by:

a. Ashcroft Industrial Instruments (Dresser). With Plus Performance.

b. Forboro/Jordan, Inc. Equivalent model

5. Gauges sleeve pressure as manufactured by:

a. Red Valve Co., Inc.

b. Ronningen-Petter.

c. Onyx.

d. No Equal.

6. Snubbers as manufactured byL

a. Cajon Co.

b. Weksler Instruments, Corp.

c. Ashcroft.

d. No Equal.

7. Pulsation dampeners as manufactured by:

a. Cajon Co.

b. Weksler Instruments, Corp.

c. Ashcroft.

d. No Equal.

2.3 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent technology.

2.4 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 3 - 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

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SECTION 40 91 21

TEMPERATURE TRANSMITTER

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation 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 TEMPERATURE TRANSMITTERS

A. Room Temperature Transmitters

1. Pressure transmitter shall be 24-28 VDC powered from PLC panel power supply, Foxboro I/A Series, or equal. Power supply shall be VDC powered from PLC panel power supply. Transmitter shall be wall mounted with bare transducer element below sensing room temperature. Signal output shall be 4 to 20 mA.

2. Temperature transducer shall be RTD type. Element shall be bare connected directly to transmitter. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be +/- 0.0 degrees Fahrenheit.

B. Water Temperature Transmitters

1. Pressure transmitter shall be 24-28 VDC powered from PLC panel power supply, Foxboro I/A Series or equal. Signal output shall be 4 to 20mA. Transmitter shall be wall mounted with conduit for RTD cable.

2. Temperature transducer shall be RTD type. Element shall be submersible and connect to submersible RTD cabling with submersible connection. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be +/- 0.1 degrees Fahrenheit.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

END OF SECTION

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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:

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 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)

1. 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 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. MODBUS TCP/IP

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 HART 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. CONTRACTOR shall field verify length of cable for connection. Electrodes shall be 316L stainless steel.

B. Flanged connections shall be constructed of 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. Magnetic flow meters shall be NSF 61 certified.

D. Meter housing shall be rated for NEMA 6P 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: 0.5 percent o.r. at 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. Meter shall be configured to provide a minimum accuracy of 0.5 percent o.r. at velocities over 3 feet per second with the piping configurations as shown on Contract Drawings. Meters shall be ordered with Design Option "I" for Oupx0dwn configuration.

I. Magnetic flow meters shall be **Proline Promag W 400 by Endress+Hauser,** no approved equal.

2.3 PRESSURE SWITCH

A. Low pressure and high pressure cutoff switches shall be bourdon tube type with stainless steel wetted parts. Low pressure switches shall have an adjustable operating range between 5psi to 75 psi and high pressure switches shall have an adjustable

operating range between 30psi to 400psi. The switch setting shall be adjustable and initially set as shown on the Contract Drawings. The switch shall be rated for the pressure of the system where it is installed with a safety factor of 1.5.

B. Low pressure switches shall have a minimum adjustable deadband of 3psi and high pressure switches shall have a minimum adjustable deadband of 30psi. Switch shall be SPDT, closing on increased pressure or closing on decreased pressure (as applicable), 4A 120 VAC.

C. Pressure switches shall be **Series DA-41 by Mercoid (Dwyer),** or approved equal.

2.4 PRESSURE TRANSMITTER

A. 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 61 drinking water certification. Pressure transmitters shall be **Rosemount Series 3051**, or approved equal.

2.5 GUIDED LEVEL SENSOR

A. Guided level sensors shall be coax probe guided wave radar level sensor type. Coax probe shall be 42.4mm in diameter and shall be the total length as shown on the Contract Drawings.

B. Guided level sensor shall have loop powered with 4-20mA HART output and shall have a SD02 4-line display in a plastic housing. Sensor shall be factory set for 0-in blocking distance and shall have a 3-point calibration. Sensor shall be sealed for 0-inch blocking distance with 15 psi pressure on probe side.

C. Guided level sensor shall have 1-1/2-inch threaded NPT connection.

D. Guided level sensor shall be **Model FMP51 by Endress+Hauser**, no approved equal.

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 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.

3.3 METER CALIBRATION

A. Meters shall be field calibrated to verify proper operation within the expected flow ranges for the project.

- END OF SECTION -

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SECTION 43 42 22
BLADDER STYLE SURGE TANK

PART 1 GENERAL

1.1 SUMMARY

A. The work described by this section of specifications consists of furnishing all equipment, materials, and labor to provide, install, and test two (2) vertical bladder-type surge tank to minimize hydraulic transient pressures from shock waves due to pump start-up, shutdown or valve closure for the potable water pump station as shown in the Contract Drawings and specified in the Contract Documents.

B. The Work included in this section consists of the furnishing of a complete surge control system and system's appurtenances for the surge protection of a pump station to prevent fluid column separation and/or to limit pressure transients in the pipeline system following pump start-up, pump shutdown (including a power failure situation), or valve closure. The pressure transients in the pipeline system following the conditions described above, must not exceed the pressure rating of the piping at any point in the pipeline system.

C. Unit Responsibility - The entire surge control system shall be designed and supplied by a single manufacturer. However, this shall not relieve CONTRACTOR's responsibility for coordinating, installing, and performing their complete portion of the Work.

D. The surge tank ST-1 is to be installed in a drinking water system and as such the surge tank, appurtenances, bladder, and lining shall be NSF 61 approved and listed on the NSF database, for use with potable water applications. Proof of NSF listing of the entire tank model shall be submitted to ENGINEER. All associated appurtenances such as piping, valves, gaskets, and pressure transmitters shall also be NSF 61 certified.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Contractor Submittals
2. Section 09 90 00 Painting and Finishes
3. Section 40 05 13.33 Brass Process Piping

1.3 REFERENCES

A. The latest edition of the following publications forms a part of these Specifications to the extent referenced. The publications are referred to in the text by basic designation only.

B. CODES

1. The building code referenced herein shall be the International Building Code (IBC) as defined in Section 01 42 19 entitled "Reference Standards".
2. ASME Boiler and Pressure Vessel Code.
3. American Welding Society (AWS) Fabrication Code.
4. ASME Fabrication Code
5. National Board Inspection Code (NBIC)
6. NEMA Industrial Control Systems Code

C. COMMERCIAL STANDARDS

1.	ANSI B 16.3-85	Malleable iron threaded fittings Class 150 and 300
2.	ANSI B 16.9-86	Factory-made wrought steel butt welding fittings
3.	ASTM A 36	Rolled structural steel bars, plates, shapes, and sheet piling.
4.	ASTM A 53-87	Pipe, steel, black and hot-dipped, zinc-coated welded and seamless
5.	ASTM A 47-84	Malleable iron castings
6.	ASTM A 197-87	Cupola malleable iron
7.	ASTM A 234-87	Pipe fittings of wrought carbon steel and allow steel for moderate and elevated temperatures
8.	ASTM A 285	Pressure vessel plates, carbon steel, low- and intermediate- tensile strength intended for fusion-welded pressure vessels
9.	NEMA ICS 6	Enclosure
10.	SSPC-SP5	Shop blast surface preparation - White Metal Blasting Cleaning
11.	SSPC-SP6	Shop blast surface preparation - Commercial Blast Cleaning
12.	SSPC-SP10	Shop blast surface preparation - Near White Metal Blast Cleaning

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 - Submittal Procedures:

1. Complete dimensional fabrication drawings of the surge tank and include the dimensions of all equipment, accessories, supports, connections, outlets, and all related piping.
2. Catalog cut sheets for all accessories and piping.
3. Tank NSF 61 certification and certification for all appurtenances associated with surge tanks.
4. Tank support design with equipment weights and anchor bolt requirements.
5. Stamped calculations prepared by a professional engineer (registered in the State of Utah) for approval before tank fabrication.
6. Immediately following fabrication, and before tank shipment, provide a Certification of ASME Code stamp. This document shall be signed by the fabricator and shall bear a notary stamp for the state in which fabrication takes place and shall indicate that the code stamp has been obtained for the tank to be supplied.
7. The Surge Tank Supplier shall indicate the Gas-to-Fluid ratio (or percent of fluid in the tank), based on recommendations of the Hydraulic Transient Analysis.

B. NSF 61 documentation for all products specified herein.

1.5 QUALITY ASSURANCE

A. This specification has been constructed around a vertical bladder-type vessel as manufactured by Charlatte of America. Any related construction and/or design modifications necessitated due to the use of an alternate tank design shall be the responsibility of CONTRACTOR.

B. The Tank Supplier must have a minimum of five years of design and manufacturing experience and must submit a Hydraulic Transient Analysis for the Engineer’s approval (or verify analysis performed by others) showing: input data for the piping system, steady state flow rate and pressure head, initial and maximum expanded gas volume, and

envelope of maximum and minimum line pressure throughout the pipeline system. In addition, a predicted pressure-time history at the pump station and at other critical points in the pipeline system will also be required.

C. The manufacturer shall be iso-9001 certified which includes engineering, design, manufacturing and testing complete components. Vessel manufacturer shall manufacture their own vessels and bladders within the same plant as per quality control through ISO.

D. Manufacturer shall provide inhouse x-rays of welds if required by ASME code, hydrostatic test, and ASME inspection. ENGINEER reserves the right to inspect the vessel manufacturing facility to confirm requirement above.

1.6 WARRANTY

A. The surge control system and instrumentation shall carry a warranty of one year from initial operation or eighteen months from delivery, whichever comes first.

PART 2 PRODUCTS

2.1 GENERAL

A. The vertical bladder-type surge tank shall be provided with the manufacturer's services at the jobsite at no additional cost to OWNER. One full 8-hour day of service from manufacturer's representative shall be provided per tank to approve the tank installation and advise CONTRACTOR during startup, testing, and final adjustment of each tank. In addition to this day, one additional full 8-hour day shall be provided in a separate trip to instruct OWNER's personnel in the operation and maintenance of the tank system.

2.2 SURGE TANK

A. The tanks shall be per the following schedule:

Tag	Capacity	Type	Inlet Size	Fluid	Nominal Dia X Length	Preset Pressure	Gas Vol (max)
ST-1	300 ft^3	Horiz	16"	Drinking Water (NSF 61)	7'x9.5'	90.5 psi	240 ft^3
ST-2	14 ft^3	Vert	8"	Irrigation Water	3'x3.5'	77 psi	11.5 ft^3

B. Tanks shall be bladder type surge tank as manufactured by **Charlatte, Young Engineering and Manufacturing, Inc**., or approved equal.

C. For the surge protection purposes, the following criteria and data shall be used for

designing and sizing the surge tank:

1. Drinking Water: Vertical Turbine Pumps (assume both operate at same time):
   a) Pump DW1 Flow 2,500 gpm @ TDH of 480 feet
   b) Pump DW2 Flow 2,500 gpm @ TDH of 480 feet
2. Irrigation Water: Vertical Turbine Pumps:
   a) Pump I1 Flow 1,300 gpm @ TDH of 455 feet
3. Working pressure of 250 psi and a test pressure of 375 psi
4. Friction Factor: C=110
5. Maximum Allowable Pressure due to Surge at Discharge (Drinking Water): 225 psi
6. Maximum Allowable Pressure due to Surge at Discharge (Drinking Water): 225 psi
7. Minimum Allowable Pressure due to Surge at Discharge: 0 psi

D. Surge Tank Design and Materials

1. Materials for the tank, design, and shop fabrication and inspection shall comply with Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code with only the plate steels in Table UCS-23 of said code being used. Provide ASME code stamp, National Board Registration number and pressure rating on tank.
   a) The bladder surge tank shall be designed to withstand a full vacuum service conditions without damage to the steel shell or a bladder.
   b) The bladder surge tank design shall incorporate seismic design.
2. Minimum design pressure shall be as stated in this section of the Specifications. Perform hydrostatic testing in shop. Test pressure shall be 150% of the design pressure of the tank.
3. Bladders and replacement bladders shall be manufactured in the Surge Tank Suppliers' plant. Tanks/Vessels shall be fabricated by listed manufacturer, not contracted out.
4. Provide a 1/2-inch threaded connection at the top of the tank to contain a gas charging valve and pressure gauge. Tank shell will be constructed of deep drawn carbon steel double sub-arc welded domes and side shells with double welded seams. Tank shall be equipped with a food grade, heavy duty butyl rubber bladder. The precharge pressure will be located between the shell of the tank and the bladder. The top accessway shall be removable to allow inspection and maintenance of the bladder. The bladder shall be sized to conform to the inner shape of the vessel. Bladder tank shall be of the vertical configuration.
5. Bladder tank shall conform with NBIC.

E. Support Design

1. Structural calculations and details/drawings for the bladder surge tank supports and their slab/footings below to be provided by Surge Tank Supplier and/or CONTRACTOR. Structural design for supports shall include the tank, supports, slabs/footings, and anchor bolts and shall be designed based upon local building codes in addition to the following criteria:
   a) Calculated reaction loads from surge tank design including surge and seismic.
   b) Design for a hydrostatic operating pressure of 250 psi and a test pressure of 375 psi with no reactive load permitted through the inlet/outlet piping.
   c) Support tank by support legs (four minimum) for attaching to a concrete floor slab or concrete pedestal supports, as shown on the Contract Drawings.

Material of construction shall comply with ASTM A36 or ASTM A 285, Grade C. Weld the support legs to the tank.

d) Seismic design parameters to conform to the current IBC.
e) Complete anchor bolt assembly (studs, nuts, washers, etc.) to be provided by Surge Tank Supplier or CONTRACTOR.

F. Service Conditions

1. The manufacturer shall review the plans and specifications and the surge analysis as performed by ENGINEER in regard to the system hydraulics and the surge vessel. If the Surge Tank Supplier's hydraulic analysis of the system yields varying design requirements, ENGINEER should be notified.

G. Valves

1. The tank shall be designed to function properly with inline butterfly and gates valves submitted by CONTRACTOR, as shown on the Contract Drawings. Acceptance of these valves shall be clearly stated in the surge tank submittal.
2. Safety (Pressure Relief) Valve: The valve shall have a stainless-steel body and bonnet and shall have stainless steel trim. Pressure relief valves shall be certified to ASME Section VIII, GENERAL REQUIREMENTS, UG-125, AND 126. Set at 450 psig. Valves shall be **Apollo Series 500**, or approved equal.

H. Level monitoring

1. General: Provide tank monitoring equipment per the Surge Tank Supplier's standards with 4-20mA output signals.
2. Pressure differential transmitter shall be **Rosemount Model 3051 differential pressure transmitter** or approved equal.
   a. Transmitter shall be two-wire, capacitance (DP/GP) or piezoresistive (AP/GP), high performance differential pressure transmitter.
   b. Pressure transmitter shall be NEC 501-5, NEMA code ICS6 and FM certified and have 4-20 mA output signal.

I. Painting and Coating

1. All coating and lining shall be completed at the factory per Section 09 90 00 – Painting and Finishes.

PART 3 EXECUTION

3.1 TESTING

A. FABRICATION TEST

1. The Surge Tank shall be shop tested hydrostatically to a pressure of 1.5 times the design pressure for a period of not less than 24 hours. All leaks shall be detected and immediately repaired prior to painting.

B. FIELD STATIC TEST

1. The Surge Tank and system piping shall be hydrostatically tested to the design pressure immediately following installation and before any dynamic testing. Test period shall be four hours minimum, and all leaks detected shall be immediately repaired. Finish touchup painting shall be provided as necessary.

C. FUNCTIONAL TEST

1. The surge tank manufacturer shall verify the performance of the surge protection equipment provided by recording surge pressures following a pump trip and summarize the results in a written document. During the required field visit, at least one pump trip will be required to provide field data needed for the surge model calibration. Field data will be provided to ENGINEER to develop and evaluate the surge computer model. The surge tank vendor shall provide all equipment needed to record the field data during a pump trip. The pressure shall be recorded with a pressure transducer capable of recording the surge pressures at a sample rate of 100 recordings per second. The manufacturer shall provide temporary transducers and software for use during testing.
2. CONTRACTOR shall provide to ENGINEER a complete report of each test performed within ten days after test completion. Reports shall include:
   a. Date and time of all testing.
   b. Description of method of testing including pumping combinations, pressure records, etc.
   c. Description of all observed leaks and method and date of repair. Description of any catastrophic failures.
   d. Certification that necessary repairs have been made.
   e. Signature of CONTRACTOR and Manufacturer's representative.

3.2 TANK INSTALLATION

A. The tank shall be installed in accordance with the manufacturer's suggested procedures. All supports, piping, valves, and related appurtenances shall be provided and installed by CONTRACTOR at no additional cost to OWNER.

- END OF SECTION –

PART 5
FIGURES