

# ***Dewatering Building HVAC Improvements***

## ***Project Manual***

### ***Volume 1 of 2: Specifications***

**ENGINEER Project No.: 70123-000**

***October 2024***

#### **OWNER**

Central Weber Sewer Improvement District  
2618 Pioneer Road  
Ogden, Utah 84404

#### **ENGINEER**

Hazen and Sawyer  
10619 South Jordan Gateway, Suite 130  
South Jordan, UT 84095  
(385) 429-1750

#### **BID SET**



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SECTION 00 01 01

TITLE PAGE AND PE CERTIFICATIONS

**PROJECT MANUAL  
FOR  
DEWATERING BUILDING HVAC IMPROVEMENTS**

**October 2024**

**Professional Engineer Certifications**



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Divisions: Electrical



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## TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
<b>BIDDING DOCUMENTS</b>		
00 11 10	Invitation for Bids	009
00 20 00	Instructions to Bidders	012
00 40 00	Bid Form	026
00 43 00	Bid Bond	043
<b>CONTRACTUAL DOCUMENTS</b>		
00 51 00	Notice of Award	045
00 52 00	Agreement	047
00 55 00	Notice to Proceed	058
00 61 00	Performance Bond	060
00 61 50	Payment Bond	064
00 65 00	Certificate of Substantial Completion	068
<b>CONDITIONS OF THE CONTRACT</b>		
00 72 00	General Conditions	070
00 73 00	Supplementary Conditions	149
<b>TECHNICAL SPECIFICATIONS</b>		
<b>DIVISION 01</b>		
01 11 00	Summary of Work	163
01 14 00	Coordination with Owner's Operations	167
01 25 00	Substitution Procedures	176
01 31 19	Project Meetings	180
01 33 00	Submittal Procedures	187
01 45 33	Special Inspections	199
01 51 00	Temporary Utilities	283
01 55 00	Contractor Access and Parking	290
01 61 00	Product Requirements and Options	293
01 65 00	Product Delivery Requirements	298
01 66 00	Product Storage and Protection Requirements	302
01 73 00	Demolition and Execution of Work	306
01 73 23	Anchorage and Bracing of Nonstructural Components	324
01 74 00	Cleaning and Waste Management	332
01 75 00	Checkout and Startup Procedures	338
01 78 23	Operations and Maintenance Data	344
01 78 39	Project Record Documents	351

**Table of Contents (continued)****DIVISION 01 (continued)**

01 78 43	Spare Parts and Extra Material	357
01 79 00	Instruction of Owner's Personnel	360

**DIVISION 03**

03 11 00	Concrete Formwork	366
03 15 00	Concrete Accessories	374
03 30 00	Cast in Place Concrete	383

**DIVISION 05**

05 05 23	Metal Fastening	412
05 10 00	Metal Materials	427
05 31 00	Metal Decking	431
05 50 00	Metal Fabrication	434

**DIVISION 06**

06 10 00	Rough Carpentry	437
----------	-----------------	-----

**DIVISION 07**

07 53 23	Single Ply Membrane Roofing (EPDM)	442
07 60 00	Flashing and Sheet Metal	448
07 61 13	Standing Seam Metal Roofing and Wall Panels	451
07 70 00	Roof Specialties and Accessories	457
07 90 00	Joint Fillers, Sealants and Caulking	461

**DIVISION 09**

09 90 00	Painting	467
----------	----------	-----

**DIVISION 22**

22 05 00	Common Results for Plumbing	484
22 05 16	Expansion Fittings and Loops for Plumbing Piping	499
22 05 19	Meters and Gauges for Plumbing Piping	503
22 05 23	General Duty Valves for Plumbing Piping	508
22 05 29	Hangers and Supports for Plumbing Piping	516
22 05 48	Vibration and Seismic Controls for Plumbing Piping	525
22 05 53	Identification for Plumbing Piping	532
22 07 19	Plumbing Piping Insulation	537
22 10 13	Facility Fuel Piping	548
22 11 13	Facility Water Distribution Piping	557
22 11 19	Domestic Water Piping Specialties	569

**DIVISION 23**

23 00 00	Basic HVAC Requirements	578
23 05 13	General Motor Requirements for HVAC	599

**Table of Contents (continued)****DIVISION 23 (continued)**

23 05 23	General-Duty Valves for HVAC Piping	609
23 05 29	Hangers and Supports for HVAC Piping	618
23 05 48	Vibration and Seismic Controls for HVAC Piping	628
23 05 53	Identification for HVAC Piping Ductwork	642
23 05 93	HVAC Balancing	647
23 05 95	HVAC Field Testing	667
23 07 00	HVAC Insulation	678
23 08 00	Commissioning of HVAC System	691
23 09 00	HVAC Automatic Temperature Controls	699
23 29 23	Variable Frequency Drives	718
23 31 13	Metal Ducts and Duct Accessories	723
23 31 16	Nonmetal Ducts and Duct Accessories	736
23 34 00	HVAC Fans	767
23 40 00	HVAC Air Cleaning	781
23 51 23	Flue Gas Vents	787
23 75 00	Custom-Packaged HVAC Equipment	793
23 81 26	Split-System Air Conditioners	812

**DIVISION 26**

26 05 00	Basic Electrical Requirements	823
26 05 19	Low Voltage Conductors and Cables	835
26 05 26	Grounding and Bonding for Electrical Systems	853
26 05 29	Hangers and Supports for Electrical Systems	857
26 05 33.13	Conduit for Electrical Systems	862
26 05 33.16	Boxes for Electrical Systems	885
26 05 53	Identification for Electrical Systems	893
26 09 16	Electric Controls and Relays	897
26 22 00	Low-Voltage Transformers	905
26 24 16	Panelboards	911
26 24 19	Low Voltage Motor Control Centers	919
26 27 26	Wiring Devices	939
26 28 16.16	Enclosed Switches	944
26 29 23	Low Voltage Variable Frequency Motor Controllers	949
26 43 13	Surge Protective Devices	970
26 50 00	Lighting	977

**DIVISION 28**

28 46 20	Fire Alarm Systems	985
----------	--------------------	-----

**DIVISION 40**

40 61 13	Process Control System General Provisions	1001
40 61 15	Process Control System Submittals	1011
40 61 21	Process Control System Testing	1022

**Table of Contents (continued)****DIVISION 40 (continued)**

40 61 21.71	Factory Witness Test	1025
40 61 21.72	Field Testing	1029
40 61 21.73	Final Acceptance Test	1034
40 61 23	Signal Coordination Requirements	1036
40 61 91	Process Control System Instrument List	1039
40 61 93	Process Control System Input/Output List	1042
40 61 96	Process Control Descriptions	1048
40 62 63	Operator Interface Terminals (OIT)	1052
40 63 43	Programmable Logic Controllers (PLC)	1054
40 66 00	Network and Communication Equipment	1061
40 67 00	Control System Equipment Panels and Racks	1065
40 67 63	Uninterruptible Power Systems	1074
40 68 00.13	Process Control Software	1078
40 70 00	Instrumentation For Process Systems	1080
40 71 79.16	Flow Switches	1087
40 74 00	Temperature Instruments	1089
40 76 21	Single Point Gas Monitoring Systems	1093
40 76 29	Ammonia Gas Monitoring Systems	1096
40 78 00	Panel Mounted Instruments	1098

**VOLUME 2 – DRAWINGS**

*“Dewatering Building HVAC Improvements”  
(Bound separately)*

**00 11 10  
INVITATION FOR BIDS**

Sealed Bids for the **Dewatering Building HVAC Improvements Project** will be received from pre-qualified Contractors by the **Central Weber Sewer Improvement District (CWSID)** until **2:00 p.m.** Mountain Standard Time on **Tuesday, November 26, 2024**, at which time the Bids will be evaluated as described in the Contract Documents.

Any Bids received after the specified date will not be considered.

**DESCRIPTION AND LOCATION OF WORK:**

The Work to be performed under this Contract includes, but is not limited to, constructing the Work described below and all appurtenances related to the Work. The Work shall be as follows:

- Demolition and removal of the existing HVAC air handling unit and associated duct work.
- Demolition and removal of existing electrical UPS system and HVAC RIO.
- Installation of new HVAC air handling unit and duct work.
- Installation of related HVAC electrical items and control panels.
- Structural modifications to the existing building for duct work and fan openings.

The Work is located at the following Site:

- Central Weber Sewer Improvement District, 2618 Pioneer Road, Ogden, UT 84404

The bid timeline is provided in the following table.

<b>Date</b>	<b>Selection Process</b>
October 18, 2024	Issue Invitation for Bids
October 29, 2024	Mandatory pre-Bid Conference (1 pm MST)
November 22, 2024	End of Inquiries, Questions, and Interpretation Period (2 pm MST)
November 25, 2024	Final Addendum Issued (if required)
November 26, 2024	Bid submittal due (2 pm MST)
December 17, 2024	Anticipated Notice of Award

The Engineer for the Bid Documents is:

**Hazen and Sawyer**  
**10619 South Jordan Gateway, Suite 130**  
**South Jordan, UT 84095**

**Contact: Chris Thunhorst**  
**385.985.9574**

[cthunhorst@hazenandsawyer.com](mailto:cthunhorst@hazenandsawyer.com)

**OBTAINING CONTRACT DOCUMENTS:** The Contract Documents are titled: Dewatering Building HVAC Improvements Project. All Contract Documents will be sent to the prequalified Contractors as electronic portable document format (pdf) files. Contract Documents will also be made available on the CWSID website. No printed copies will be provided. The costs to prepare Bids as described in the Contract Documents are the sole responsibility of the Contractor.

**MANDATORY PRE-BID CONFERENCE:** A mandatory pre-Bid Conference will be held on the date and time specified in the bid timeline table at the Owner's office located at 2618 pioneer Road, Ogden, Utah 84404.

**LIST OF PREQUALIFIED GENERAL CONTRACTORS:** CWSID authorized use of a prequalification procedure to determine and select General Contractors eligible to bid and construct the Dewatering Building HVAC Improvements Project. Based upon the Statements of Qualifications received in response to the District's Request for Statements of Qualifications from General Contractors, only the following General Contractors are prequalified to bid and construct the project:

- Archer Western Construction, LLC
- COP Construction
- Gerber Construction, Inc.
- MGC Contractors, Inc.
- VanCon, Inc.

**RECEIPT OF BIDS:** Sealed Hard Copy Bids will be received in person at the CWSID office. Any Bids received after the specified time or through a method other than in-person will not be considered. Refer to Bid Instructions for documents required for a complete Bid.

**INQUIRIES, QUESTIONS, AND INTERPRETATION PERIOD:** Any questions about the meaning or intent of the Contract Documents are to be submitted to the Engineer before the End of Inquiries, Questions, and Interpretation Period. Interpretations or clarifications considered necessary by Owner and Engineer in response to such questions will be issued by Addenda delivered to all parties.

**OPENING OF BIDS:** The Bids will be opened in person. The names of the Contractors responding to the Request for Bids and their bid amounts will be available shortly thereafter. The Owner and Engineer will publicly review and evaluate the Bids following receipt.

**OWNER'S RIGHTS RESERVED:** The Owner may, at reasonable times, inspect the part of the plant or place of business of Contractor, any subcontractor, or any supplier that is related to the performance of any contract awarded or to be awarded by the Owner. The Owner reserves the right to reject any or all Bids, to waive any informality in a Bid, and to make awards in the interest of the Owner.

**END OF ADVERTISEMENT FOR BIDS**

**SECTION 00 20 00**  
**INSTRUCTIONS TO BIDDERS**  
**TABLE OF ARTICLES**

1. Defined Terms
2. Bids Received
3. Location and Description of Project
4. Copies of Bidding Documents
5. Qualifications of Bidders
6. Examination of Bidding Documents, Other Related Data and Site
7. Pre-Bid Conference
8. Site and Other Areas
9. Interpretations and Addenda
10. Bid Security
11. Contract Times
12. Liquidated and Special Damages
13. Substitute and "Or Equal" Items
14. Subcontractors, Suppliers and Others
15. Preparation of Bid
16. Basis of Bids; Comparison of Bids
17. Submittal of Bid
18. Modification or Withdrawal of Bid
19. Opening of Bids
20. Disqualification of Bidders
21. Bids to Remain Subject to Acceptance



22. Evaluation of Bids and Award of Contract
23. Contract Securities
24. Contractor's Insurance
25. Signing of Agreement
26. Notice to Proceed
27. Sales and Use Taxes
28. Additional Requirements

#### **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 which are applicable to both the singular and plural thereof.
  - A. Issuing Office: The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
  - B. Bidding Documents Holder: A party recorded by Engineer as having obtained the Bidding Documents as required by the Invitation for Bids.

#### **ARTICLE 2 – BIDS RECEIVED**

- 2.01 Refer to the Invitation for Bids for information on receipt of Bids.

#### **ARTICLE 3 – LOCATION AND DESCRIPTION OF PROJECT**

- 3.01 Refer to Section 01 11 00 – Summary of Work, in the General Requirements for the location and description of the Project.

#### **ARTICLE 4 – COPIES OF BIDDING DOCUMENTS**

- 4.01 Refer to the Invitation for Bids for information on location where Bidders may examine and obtain the Bidding Documents.

- 4.02 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.
- 4.03 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 grant permission for any other use.

## **ARTICLE 5 – QUALIFICATIONS OF BIDDERS**

- 5.01 Bidders shall be experienced in the kind of Work to be performed, shall have the necessary equipment therefore, and shall possess sufficient capital to properly execute the Work within the time allowed. Bids received from Bidders who have previously failed to complete work within the time required, or who have previously performed similar work in an unsatisfactory manner, may be rejected. A Bid may be rejected if Bidder cannot show that Bidder has the necessary ability, plant, and equipment to commence the Work at the time prescribed and thereafter to prosecute and complete the Work at the rate or within the times specified. A Bid may be rejected if Bidder is already obligated for the performance of other work which would delay the commencement, prosecution or completion of the Work.
- 5.02 Bidders shall be qualified to do business in the state where the Project is located or covenant to obtain such qualification prior to signing the Agreement.
- 5.03 Each Bidder must be prequalified and a Bidding Document Holder. Bids submitted by Bidders not on the list of Bidding Documents (Plan) Holders will not be opened.

## **ARTICLE 6 – EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA AND SITE**

- 6.01 Subsurface and Physical Conditions
- A. Supplementary Conditions identify:
1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site that have been utilized by Engineer in preparation of the Bidding Documents.
  2. Drawings of physical conditions relating to existing surface or subsurface structures (except underground Facilities), which are at or contiguous to the Site, that have been utilized by Engineer in preparation of Bidding Documents.
- 6.02 Underground Facilities – Physical Conditions

- A. Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.
- 6.03 Hazardous Environmental Condition
- A. Owner has no actual knowledge of a Hazardous Environmental Condition at the Site.
- 6.04 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 unforeseen subsurface or physical conditions appear in Paragraphs 4.02, 4.03, 4.04 and 4.05 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 4.06 of the General Conditions.
- 6.05 Other Related Data (Not Used).
- 6.06 On request, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a Bid. Bidder shall fill all holes and clean up and restore the Site to its original conditions upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all Laws and Regulations relative to such explorations, investigations, tests, and studies.
- A. Owner will conduct a Site walk through during the Pre-Bid Conference.
- 6.07 Reference is made to Section 01 11 00 – Summary of Work for identification of the general nature of other work to be performed at the Site by Owner or others (such as utilities and other prime contractors) that relates to the Work for which a Bid is to be submitted. On request, Owner will provide to Bidder, for examination, access to or copies of the contract documents for such other work.
- 6.08 It is the responsibility of Bidder, before submitting a Bid to:
- A. Examine and carefully study the Bidding Documents, the other related data identified in the Bidding Documents and Addenda (if any);
  - B. Visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

- C. Become familiar with and satisfy Bidder as to the Laws and Regulations that may affect cost, progress and performance of the Work;
  - D. Consider the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in Bidding Documents, including "technical data," with respect to the effect of such information, observation, and documents on:
    - 1. The cost, progress and performance of the Work;
    - 2. The means, methods, techniques, sequences and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences and procedures of construction expressly required by the Bidding Documents; and
    - 3. Bidder's safety precautions and programs;
  - E. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for the performance of the Work at the price(s) bid and within the times required and in accordance with the other terms and conditions of the Bidding Documents;
  - F. Become aware of the general nature of work (if any) to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;
  - G. Promptly give Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and
  - H. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.
- 6.09 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 6, that without exception the Bid is premised upon performing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, or procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing the Work.

**ARTICLE 7 – PRE-BID CONFERENCE**

- 7.01 **A MANDATORY pre-Bid Conference** will be held at the date and time specified in the Invitation for Bids, at the Owner's office located at 2618 Pioneer Road, Ogden, Utah 84404. Representatives of Owner and Engineer will be present to discuss the Project. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions raised at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

**ARTICLE 8 – SITE AND OTHER AREAS**

- 8.01 The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner unless otherwise provided in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment, to be incorporated into the Work are to be obtained and paid for by Contractor.

**ARTICLE 9 – INTERPRETATIONS AND ADDENDA**

- 9.01 All questions about the meaning or intent of the Bidding Documents shall be submitted to Engineer in writing. To receive consideration, questions must be received by Engineer by the End of Inquiries, Questions, and Interpretation Period. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all parties recorded by Engineer as having received the Bidding Documents prior to the date for the opening of Bids. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.
- 9.02 Addenda may also be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer. Such Addenda, if any, will be issued in the manner and within the time period stated in the Invitation to Bidders.

**ARTICLE 10 – BID SECURITY**

- 10.01 Bids shall be accompanied by either a Bid Bond for the amount of five percent (5%) of the full amount of the Bid issued by a bonding company authorized to do business in the State of Utah; or by a certified check, cashier's check, or letter of credit satisfactory to the Owner. The required Bid Bond(s), certified checks, cashier's checks, or letters of credit shall be made payable to Owner.

- 10.02 Bid bond shall be on the form (Bid Guaranty and Contract Bond) bound in the Bidding Documents. Bid bond shall be issued by a surety complying with the requirements of Paragraphs 5.01 and 5.02 of the General Conditions.
- 10.03 Bid security of the Successful Bidder will be retained until such Bidder has executed the Agreement, furnished the required contract security, and complied with the other conditions of the Notice of Award, whereupon the bid security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within 15 days of the Notice of Award, Owner may annul the Notice of Award and may retain from the bid security an amount equal to the Bid Bond.
- 10.04 Bid security of the three lowest Bidders may be retained by Owner until the earlier of the seventh day after the execution of the Agreement by the Successful Bidder or the sixtieth (60) day after the Bid opening. The bid security of other Bidders will be returned within seven days of the Bid opening.
- 10.05 Successful Bidder, who submitted Bid Security by certified check, cashier's check or letter of credit, shall be required to file a performance and payment bond in the full amount of the contract.

#### **ARTICLE 11 – CONTRACT TIMES**

- 11.01 The number of days within which or the dates by which the Work is to be substantially completed and also completed and ready for final payment (the Contract Times) are set forth in the Agreement.

#### **ARTICLE 12 – LIQUIDATED AND SPECIAL DAMAGES**

- 12.01 Provisions for liquidated and special damages, if any, are set forth in the Agreement.

#### **ARTICLE 13 – SUBSTITUTE AND “OR EQUAL” ITEMS**

- 13.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or “or-equal” items. Whenever it is specified or described in the Bidding Documents that a substitute or “or-equal” item of material or equipment may be furnished or used by Contractor if accepted by Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement. The procedure for submittal of any such application by Contractor and consideration by Engineer is set forth in the General Conditions which may be supplemented in the General Requirements (Division 01).

- 13.02 Refer to Section 01 25 00 – Substitution Procedures of the General Requirements for the period of time after the Effective Date of the Agreement during which the Engineer will accept applications for substitute items of material or equipment.

#### **ARTICLE 14 – SUBCONTRACTORS, SUPPLIERS AND OTHERS**

- 14.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within five (5) days after Bid opening submit to Owner a list of all such Subcontractors, Suppliers, other individuals, and entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualifications for each such Subcontractor, Supplier, individual, and entity if requested by Owner. 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 the apparent Successful Bidder to submit an acceptable substitute without an increase in the Bid price.
- 14.02 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 and other individuals or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.06 of the General Conditions.
- 14.03 Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.
- 14.04 HVAC services shall be performed by a Subcontractor specializing in HVAC systems.

#### **ARTICLE 15 – PREPARATION OF BIDS**

- 15.01 A Bid shall be made on the Bid Form bound in Project Manual. The Bid Form shall not be separated from the Bid Submittal Document nor shall it be altered in any way. The entire Bid Submittal Document must be submitted. Only the completed Bid Submittal Document is required to be submitted.
- 15.02 All blanks in the Bid Form shall be completed in ink or by a typewriter 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 Bid Item listed therein. In the case of optional alternatives, the words "No Bid", "No Change", or "Not Applicable" may be entered. Ditto marks shall not be used.

15.03 A Bid shall be executed as stated below.

- A. A Bid by an individual shall indicate the Bidder's name and official address.
- B. A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title shall appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be indicated.
- C. A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be indicated.
- D. A Bid by a corporation shall be executed in the corporate name by an officer of the corporation and shall be accompanied by a certified copy of a resolution of the board of directors authorizing the person signing the Bid to do so on behalf of the corporation. The corporate seal shall be affixed and attested by the secretary or an assistant secretary of the corporation. The state of incorporation and the official corporate address shall be indicated.
- E. A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be indicated below the signature.
- F. All names shall be typed printed in ink below the signature.
- G. If applicable, 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 agree in writing to obtain such authority and qualification prior to award of Contract and attach such statement to the Bid.
- H. Contractor's license or registration number, if any, shall be entered in the space provided on the Bid Form.

15.04 Bid shall contain an acknowledgment of the receipt of all Addenda, the numbers of which shall be filled in at the space provided on the Bid Form.

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

15.06 The following listed documents are the Bid Submittal Documents shall be submitted with the Bid. Each document shall be executed in the manner described in Paragraph 15.03 unless another manner is indicated.



- A. Bid Form (Section 00 40 00 – Bid Form)
- B. Bid Bond (Section 00 43 00 – Bid Bond)

## **ARTICLE 16 – BASIS OF BIDS; COMPARISON OF BIDS**

### 16.01 Single Lump Sum

- A. Bidder shall submit Bid on the basis of single lump sum as set forth in the Bid Form. Bidder shall include write-in bid amounts and allowances as set forth in the Bid Form and as described in Section 01 20 00 – Measurement and Payment.

16.02 Discrepancies between words and numerals will be resolved in favor of words. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

16.03 Bidder shall include, elsewhere in Bid, costs set forth in Paragraph 11.02.B of the General Conditions to complete the Work associated with the material, equipment, or other designated items to be furnished under cash allowance(s).

## **ARTICLE 17 – SUBMITTAL OF BID**

17.01 A Bid shall be received no later than the date and time prescribed and at the place indicated in the Invitation for Bids.

17.02 Bid shall be marked with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted) the name and address of the Bidder and its license or registration number, if applicable. Bid shall be accompanied by Bid security and other required documents.

## **ARTICLE 18 – MODIFICATION OR WITHDRAWAL OF BID**

### 18.01 Withdrawal Prior to Bid Opening:

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

### 18.02 Modification Prior to Bid Opening:

- A. If a Bidder wishes to modify its Bid, Bidder must withdraw its initial Bid in the manner specified in Paragraph 18.01.A of these Instructions to Bidders and submit a new Bid.

#### **ARTICLE 19 – OPENING OF BIDS**

- 19.01 Bids will be opened as described in the Invitation for Bids. An abstract of the Bids will be made available to Bidders after the opening.
- 19.02 Bids received by mail or otherwise after the date and time specified for the opening of Bids will not be accepted and will be returned to the Bidder unopened.

#### **ARTICLE 20 – DISQUALIFICATION OF BIDDERS**

- 20.01 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

#### **ARTICLE 21 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE**

- 21.01 All Bids shall remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of that period.

#### **ARTICLE 22 – EVALUATION OF BIDS AND AWARD OF CONTRACT**

- 22.01 Owner reserves the right to reject any or all Bids, including without limitation the right to reject any or all nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be not responsible. Owner also reserves the right to waive any informality not involving price, time or changes in the Work.
- 22.02 Owner reserves the right to reject any Bid not accompanied by specified documentation and Bid security.
- 22.03 Owner reserves the right to reject any Bid that, in its sole discretion, is considered to be unbalanced or unreasonable as to the amount bid for any lump sum or unit price item.
- 22.04 In evaluating Bidders, Owner will consider the qualifications of Bidders, whether or not their Bids comply with the prescribed requirements, the alternatives, if any, the lump sum and unit prices, and other data as may be requested in the Bid Form or prior to the Notice of Award.

- 22.05 Owner may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the General Conditions.
- 22.06 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of the Bidders to perform the Work in accordance with the Contract Documents. Owner reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to Owner's satisfaction.
- 22.07 Owner reserves the right to reject any and all Bids, to waive any informalities or irregularities, and further, reserves the right to accept any Bids or parts of Bids. Owner reserves the right to accept any Bid deemed to be in its best interests even though the Bid chosen may result in the award of the Contract to a Bidder whose Bid is not, on a mathematical basis alone, the low Bid.
- 22.08 If a Contract is to be awarded, Owner will award the Contract to the lowest responsive, best, and responsible Bidder who has neither been disqualified nor rejected pursuant to Article 20 of the Instructions to Bidders or this Article 22.

### **ARTICLE 23 – CONTRACT SECURITIES**

- 23.01 Performance and Payment Bond shall be in the full amount of the Bid. The amounts of and other requirements for Performance and Payment Bonds are stated in Paragraph 5.01 of the General Conditions. The requirements for delivery of Bonds are stated in Paragraph 2.01 of the General Conditions.

### **ARTICLE 24 – CONTRACTOR'S INSURANCE**

- 24.01 The requirements for Contractor's insurance are stated in Article 5 of the General Conditions. The requirements for delivery of certificates of insurance and other evidence of insurance are stated in Paragraph 2.01.B of the General Conditions.
- 24.02 Successful Bidder shall within fifteen (15) days from the date of the Notice of Award deliver to Owner, for review and approval, the required policies of insurance. Upon approval, the policies will be returned to the Bidder and Bidder shall submit certificates of insurance and other evidence of insurance to the Owner as stated in the General Conditions.

**ARTICLE 25 – SIGNING OF AGREEMENT**

25.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement along with the other Contract Documents which are identified in the Agreement as attached thereto. Within fifteen (15) days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within ten days thereafter, Owner will deliver one fully signed counterpart to Successful Bidder.

**ARTICLE 26 – NOTICE TO PROCEED**

26.01 Issuance of the Notice to Proceed shall be as stated in Article 2 of the General Conditions.

**ARTICLE 27 – SALES AND USE TAXES**

27.01 Refer to the Paragraph SC-7.10 of the Supplementary Conditions for information on Owner's inclusion and/or exemption from sales and use taxes on materials and equipment to be incorporated into the Work.

**ARTICLE 28 – ADDITIONAL REQUIREMENTS**

28.01 The Bidder to whom the Contract is awarded shall disclose in writing the knowledge of any business relationship or interest that any Owner employee, an employee's immediate family, or any other contractor or subcontractor of said Successful Bidder may have with the Successful Bidder.

**END OF INSTRUCTIONS TO BIDDERS**

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**SECTION 00 40 00**  
**BID FORM**

**TABLE OF ARTICLES**

1. Bid Recipient
2. Bidder's Acknowledgements
3. Bidder's Representations
4. Bidder's Certifications
5. Basis of Bid
6. Certified List of Subcontractors
7. Certification of Equipment/Materials Manufacturers
8. Time of Completion
9. List of Required Attachments to this Bid
10. Defined Terms
11. Bid Submittal

**ARTICLE 1 – BID RECIPIENT**

1.01 This Bid is submitted to:

Central Weber Sewer Improvement District  
c/o James Dixon, PE  
2618 Pioneer Road  
Ogden, UT 84404

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 price(s) and within the times indicated in this Bid and in accordance with the Bidding Documents.

**ARTICLE 2 – BIDDER'S ACKNOWLEDGEMENTS**

2.01 Bidder accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid

10/21/2024

Central Weber Sewer Improvement District  
Dewatering Building HVAC Improvements

Bid Form  
Page 00 40 10-1

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. Bidder will sign the Agreement and will furnish the required contract security, and other required documents within the time periods set forth in the Bidding Documents.

**ARTICLE 3 – BIDDER’S REPRESENTATIONS**

3.01 In submitting this Bid, Bidder represents that:

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

Addendum No.	Date Received	Addendum No.	Date Received

- B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Bidder has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities), if any, that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”.
- E. Bidder has considered the information known to Bidder, information commonly known to contractors doing business in the locality of the Site, information and observations obtained from visits to the Site, the Bidding Documents, and the Site-related reports and drawings identified in the Bidding Documents with respect to the effect of such information, observations, and documents on:
  - 1. The cost, progress and performance of the Work.
  - 2. The means, methods, techniques, sequences and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder.

3. Bidder's safety precautions and programs.
- F. Based on the information and observations referred to in Paragraph 3.01.E, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times required and in accordance with the other terms and conditions of the Bidding Documents.
  - G. Bidder is aware of the general nature of work (if any) 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, and discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.
  - I. Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

#### **ARTICLE 4 – BIDDER'S CERTIFICATIONS**

##### 4.01 Bidder certifies that:

- A. This Bid is genuine and is not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation.
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not engaged in corrupt, fraudulent, collusive or coercive practices in competing for the Contract. For the purposes of the Paragraph 4.01.D.
  1. "Corrupt practice" means the offering, giving, or soliciting of anything 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 to 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.



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

## **ARTICLE 5 – BASIS OF BID**

5.01 Bidder will complete the Work in accordance with the Contract Documents for the amount as listed below. Total bid amount(s) shall be shown in words and numbers. In case of discrepancy, the bid amount shown in words will govern.

5.02 Mobilization costs shall be limited to 3% of the Contract price and will be paid in two monthly progress payments. Each of the two payments will be 50% of the total amount for mobilization.

5.03 Demobilization shall be limited to 3% of the Contract price and shall be included with the application for payment following substantial completion.

5.04 Bid Alternate 1 – Door & Door Frame Replacement: Replacement of two 5'-0" x 7'-0" and one 3'-0" x 7'-0" hollow metal doors and frames including removal of existing door and frame, all materials, hardware, and painting required to install new door and frame.

5.05 Bid Alternate 2 – Structural Steel Coating: Sandblast and clean all structural steel. Paint steel beams, columns, and roof panels with protective coating.



5.06 **Unit Price Bid Items:** Provide unit prices for potential additional or deducted work. Bidder acknowledges that each Unit Price Bid Item includes an amount considered by Bidder to be adequate to cover all costs, including overhead and profit, for each separately identified item.

<b>UNIT PRICE BID ITEM SCHEDULE</b>			
<i>ITEM DESCRIPTION</i>	<i>UNIT</i>	<i>UNIT PRICE</i>	<i>TOTAL AMOUNT</i>
Lighting (LC1)	Each	\$	\$
Door & Door Frame Replacement (3'-0" Door)	Each	\$	\$
Door & Door Frame Replacement (7'-0" Door)	Each	\$	\$
Structural Steel Coating	Square Foot	\$	\$

**ARTICLE 6 – CERTIFIED LIST OF SUBCONTRACTORS**

6.01 The Bidder, \_\_\_\_\_,

as part of the procedure for the submission of Bids on this project, submits the following list of Subcontractors to be used in the performance of the Work. The list shall include all Subcontractors who will be subcontracted to provide at least \$25,000.00 of the work, list on additional paper as required. The list of Subcontractors and all responsibilities of all disciplines shall be based on requirements of the Contract Documents. Changes to this list after the Bid opening shall only be as approved by the Owner upon request by the Contractor or as required by the Owner based on upon review of Subcontractor's qualifications.

AREA OF SPECIALIZATION	SUBCONTRACTORS
Welding	
Concrete	
Rebar	
Mechanical (HVAC)	
Electrical	
Instrumentation & Controls	
System Integration	
Quality Control Testing	

6.02 It is understood and agreed that, if awarded a Contract, the Contractor will not make any additions, deletions or substitutions to this certified list without the consent of the Owner.

**CERTIFICATION AFFIDAVIT  
FOR CERTIFIED LIST OF SUBCONTRACTORS**

THE ABOVE INFORMATION IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF. I FURTHER UNDERSTAND AND AGREE THAT, IF AWARDED A CONTRACT, THIS CERTIFICATION SHALL BE ATTACHED THERETO AND BECOME A PART THEREOF.

NAME OF SIGNER:

\_\_\_\_\_

(Please Print or Type)

TITLE OF SIGNER:

\_\_\_\_\_

(Please Print or Type)

SIGNATURE: \_\_\_\_\_ DATE: \_\_\_\_\_

**ARTICLE 7 – CERTIFICATION OF EQUIPMENT/MATERIAL MANUFACTURERS**

## 7.01 Declaration of Equipment Suppliers:

- A. The Bidder shall base the Lump Sum Bid Item upon the specified and named (A) equipment/supplier items as listed in the following Owner-Selected Equipment/Supplier Schedule. If more than one (A) equipment/supplier is listed for the same equipment item, then the Bidder shall choose and base the Lump Sum Bid upon one of the specified and named (A) equipment/suppliers listed and shall so designate by circling the name of the chosen (A) equipment/supplier on the Schedule. **If Bidder's choice is not so indicated, the Lump Sum Bid will, by default, be based upon the first named (A) equipment/supplier in the Schedule.**

If an alternative (B) equipment/supplier is proposed, the desired (A) equipment/supplier must still be designated in the event that the alternate is not selected. The Contract will be awarded based on the selected (A) manufacturer. If the Owner accepts an alternate, the Contract amount will be adjusted by change order after execution of the Contract.

- B. Proposed Deducts for Proposed Equipment/Supplier Alternates:

Bidder may propose equipment/supplier alternates on the following Owner-Selected Equipment/Supplier Schedule by circling (B) and writing in an equal alternate, and by writing in the amount of deduct offered for the proposed equipment/supplier alternate. Where no space is provided on the Schedule for a write-in alternate, no such alternate will be considered.

Design of this project is based upon the (A) named equipment/suppliers as listed in the Owner-Selected Equipment/Supplier Schedule. Should a Bidder propose an equipment/supplier alternate, he shall include in his Bid any and all additional construction costs associated with the alternate and reimbursement to the Owner for any incurred engineering redesign costs associated with the alternate. The Bid shall also include any paid-up licenses necessary for the use of the equipment if required by the manufacturer.

No equipment/supplier alternate will be considered unless a deduct is offered and, in the opinion of the Owner, it conforms to the requirements of the Contract documents in all respects except for make, manufacturer, and minor details. Equipment/supplier alternates will generally be deemed "equal" provided that, in the opinion of the Owner, the alternate is the same or better than the named (A) equipment/supplier in function, performance, reliability, quality, and general configuration. Determination of equality in reference to the project requirements

will be made by the Owner. Owner's allowance of an equipment/supplier alternate will constitute neither a waiver of the requirements of the Contract Documents nor agreement by the Owner that the alternate is equal to the named (A) equipment/supplier. The Owner may determine any proposed equipment/supplier alternate to be "not desired" as the Owner determines will best suit Owner's sole best interests.

Should a proposed and circled write-in alternate be determined "not equal" or "not desired" by the Owner, or should no proposed alternate be indicated; then the Bidder must provide the named (A) equipment/supplier listed in the Owner-Selected Equipment/Supplier Schedule, and if more than one (A) equipment/supplier is listed, the name circled by the bidder must be provided.

C. Submittal Requirements for Proposed Unnamed (Write-In) Equipment/Supplier Alternates

Bidder shall submit information with its Proposal, as described below for the Owner's use in determining the equality or desirability of proposed (write-in) equipment/supplier alternates. Bidder's failure to comply with the following requirements will result in a determination by the Owner that the proposed alternate is "not desired".

For each proposed equipment/supplier alternate, Bidder shall submit with his Proposal one set of Drawings, Specifications, complete descriptive material, a detailed listing of proposed equipment, and other information, including, but not limited to, the following:

1. Dimensional and weight information on components and assemblies.
2. Catalog information.
3. Manufacturer's specifications, including materials descriptions and paint systems descriptions.
4. Complete listing of requested exceptions to the requirements of the Contract Documents.
5. Written description and Drawings regarding all changes and modifications to the Work necessary to adapt the equipment to the arrangements shown or function described in the Contract Documents.
6. Time of delivery

D. Owner Selected Equipment/Supplier Schedule

Section Number	Description	Equipment Supplier	Amount of Deduct for Alternative Equipment
23 75 00	Custom-Packaged HVAC Equipment	(A) Innovent Air Handling Equipment (Basis of Design) (A) Engineered Air (A) Haakon Industries (A) MAFNA (B) Or equal _____	
26 24 19	Low Voltage Motor Control Centers	(A) Allen-Bradley (A) Eaton (A) General Electric (A) Square D (B) Or equal _____	

NOTE: BIDDER MUST CIRCLE A BASE BID MANUFACTURER FOR EACH EQUIPMENT ITEM.



**CERTIFICATION AFFIDAVIT  
FOR EQUIPMENT/MATERIAL MANUFACTURERS**

THE ABOVE INFORMATION IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF. I FURTHER UNDERSTAND AND AGREE THAT, IF AWARDED A CONTRACT, THIS CERTIFICATION SHALL BE ATTACHED THERETO AND BECOME A PART THEREOF.

NAME OF SIGNER:

\_\_\_\_\_ (Please Print or Type)

TITLE OF SIGNER:

\_\_\_\_\_ (Please Print or Type)

SIGNATURE: \_\_\_\_\_

DATE: \_\_\_\_\_

**ARTICLE 8 – TIME OF COMPLETION**

8.01 Bidder agrees that the Work will be substantially complete and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

8.02 Bidder accepts the provisions of the Agreement as to liquidated and special damages in the event of failure to complete the Work within the Contract Times.

**ARTICLE 9 – ATTACHMENTS TO THIS BID (NOT USED)**

**ARTICLE 10 – DEFINED TERMS**

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

**ARTICLE 11 – BID SUBMITTAL**

11.01 This Bid submitted on \_\_\_\_\_, 20\_\_ by:

If Bidder is (pick one):

**AN INDIVIDUAL**

Name: \_\_\_\_\_  
(Typed or Printed)

By: \_\_\_\_\_  
(Individual's Signature)

Doing business as:  
License or Registration  
Number: \_\_\_\_\_

Business Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

E-mail: \_\_\_\_\_

**A PARTNERSHIP**

Partnership Name: \_\_\_\_\_

By: \_\_\_\_\_  
(Signature of General Partner - Attach evidence of authority to sign)

Name: \_\_\_\_\_  
(Typed or Printed)

License or Registration  
Number: \_\_\_\_\_

Business Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

Hazen and Sawyer

Project No.: 70123-000

Partnership Name: \_\_\_\_\_

E-mail: \_\_\_\_\_

**A CORPORATION**

Corporation Name: \_\_\_\_\_

\_\_\_\_\_  
(State of Incorporation)

By: \_\_\_\_\_  
(Signature – Attach evidence of authority to sign)

Name and Title: \_\_\_\_\_  
(Typed or Printed)

(CORPORATE SEAL)

Attest \_\_\_\_\_  
(Secretary)

License or Registration Number: \_\_\_\_\_

Business Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

E-mail: \_\_\_\_\_

**A LIMITED LIABILITY COMPANY**

By: \_\_\_\_\_  
(Firm Name)

\_\_\_\_\_  
(State of Formation)

By: \_\_\_\_\_  
(Signature of Member / Authorized to Sign)

\_\_\_\_\_  
(Printed or Typed Name and Title of Authorized to Sign)  
(Attach evidence of authority to sign.)

License or Registration  
Number: \_\_\_\_\_

Business Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

E-mail: \_\_\_\_\_

**A JOINT VENTURE**

Name of Joint Venture: \_\_\_\_\_  
First Joint Venturer  
Name: \_\_\_\_\_

By: \_\_\_\_\_  
(Signature of First Joint Venturer – Attach evidence of authority to sign)

Name (Typed or Printed): \_\_\_\_\_  
Title: \_\_\_\_\_

Second Joint Venturer  
Name: \_\_\_\_\_

By: \_\_\_\_\_  
(Signature of First Joint Venturer – Attach evidence of authority to sign)

Name (Typed or Printed): \_\_\_\_\_  
Title: \_\_\_\_\_

Name of Joint Venture: \_\_\_\_\_  
First Joint Venturer  
Name: \_\_\_\_\_

(Each joint venturer must sign. The manner of signing for each individual, partnership, corporation or limited liability company that is a party to the joint venture shall be in the manner indicated above).

Business Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone and fax numbers and address for receipt of communications to joint venture.

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

E-mail: \_\_\_\_\_

**END OF BID FORM**

**00 43 00  
BID BOND**

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

BIDDER *(Name and Address):*

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

OWNER *(Name and Address):*

Central Weber Sewer Improvement District  
2618 Pioneer Road  
Ogden, UT 84404

BID

Bid Due Date: November 26, 2024  
Description: Dewatering Building HVAC Improvements

BOND

Bond Number:  
Date:  
Penal sum

\_\_\_\_\_ \$ \_\_\_\_\_  
(Words) (Figures)

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

**BIDDER** \_\_\_\_\_ (Seal) **SURETY** \_\_\_\_\_ (Seal)  
Bidder's Name and Corporate Seal Surety's Name and Corporate Seal

By: \_\_\_\_\_ By: \_\_\_\_\_  
Signature Signature (Attach Power of Attorney)

\_\_\_\_\_  
Print Name Print Name

\_\_\_\_\_  
Title Title

Attest: \_\_\_\_\_ Attest: \_\_\_\_\_  
Signature Signature

\_\_\_\_\_  
Title Title

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

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation shall be null and void if:
  - 3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
  - 3.2 All Bids are rejected by Owner, or
  - 3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.



**SECTION 00 51 00  
NOTICE OF AWARD**

To: \_\_\_\_\_ Date: \_\_\_\_\_, 20\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Central Weber Sewer Improvement District, herein called Owner, represented by the undersigned has considered the Bid submitted by you for the Work and any adopted alternatives in response to its Invitation to Bid and Instructions to Bidders dated \_\_\_\_\_, 20\_\_\_\_.

Determined to be in Owner's best interest, the Owner accepts your Bid in the amount of \_\_\_\_\_

for Bid Schedules \_\_\_\_\_

and intends to execute the Agreement for this Work. You are hereby notified that your Bid has been accepted for the Work. You are required by the Instructions to Bidders to execute the formal Agreement with the undersigned Owner and to furnish the required Contractor's Performance Bond and Payment Bond, proper Insurance Certificate and other required Contract Documents within fifteen (15) days from the date of delivery of this Notice to you.

**You are required to return an acknowledged copy of this Notice of Intent to Award and all copies of the signed Agreement (leave dates blank) to the Owner for execution.**

If you fail to execute said Agreement and to furnish said bonds and certificates within 15 days from the date of delivery of this Notice, said Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your Bid as abandoned and as a forfeiture of your Bid Security. The Owner will be entitled to such other rights as may be granted by law and to award the Work covered by your Bid to another, or to re-advertise the Work or otherwise dispose thereof as the Owner may see fit.

Dated this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

**Owner**

\_\_\_\_\_  
By: \_\_\_\_\_

**ACCEPTANCE OF NOTICE**

Receipt of the above Notice of Award is hereby acknowledged this

\_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

By: \_\_\_\_\_

Title: \_\_\_\_\_

**END OF NOTICE OF AWARD**

**SECTION 00 52 00**  
**AGREEMENT**

THIS AGREEMENT is by and between the Central Weber Sewer Improvement District (hereinafter called Owner) and \_\_\_\_\_ (hereinafter called Contractor).

Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

**ARTICLE 1 – WORK**

1.01 Contractor shall at its own cost and expense furnish all labor, services, tools, materials, equipment, and incidentals necessary to complete all Work as specified or indicated in the Contract Documents to construct the Dewatering Building HVAC Improvements Project. The Work is generally described in Section 01 11 00 – Summary of Work of the General Requirements.

**ARTICLE 2 – PROJECT**

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

- A. Demolition and removal of the existing HVAC air handling unit and associated duct work.
- B. Demolition and removal of existing electrical UPS system and HVAC RIO.
- C. Installation of new HVAC air handling unit and duct work.
- D. Installation of related HVAC electrical items and control panels.
- E. Structural modifications to the existing building for duct work and fan openings.

**ARTICLE 3 – ENGINEER**

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

**ARTICLE 4 – CONTRACT TIMES**

4.01 Time is of the Essence

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

4.02 Days to Achieve Substantial Completion and Final Payment

- A. The Work shall be substantially completed, in accordance with the General Conditions, by Thursday May 30, 2026.
- B. The Work shall be completed and ready for final payment in accordance with the General Conditions by Tuesday July 30, 2026.

4.03 Liquidated Damages

- A. Owner and Contractor recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial loss, apart from the costs described in Paragraph 4.04.A, if the Work is not substantially completed within the time specified in Paragraph 4.02.A for Substantial Completion, plus any extensions thereof allowed in accordance with the General Conditions. Owner and Contractor 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 substantially completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner \$5,000 for each day that expires after the time specified in Paragraph 4.02.A above for Substantial Completion (adjusted for changes thereof, if any, made in the General Conditions) until the Work is substantially complete.

4.04 Special Damages:

- A. In addition to the amount provided for liquidated damages, Contractor shall pay Owner the actual costs reasonably incurred by Owner for engineering and inspection forces employed by Owner relative to the Work for each day that expires after the days specified in Paragraph 4.02.A for Substantial Completion (adjusted for changes thereof, if any, made in accordance with the General Conditions) until the Work is substantially complete.
- B. After Substantial Completion, if Contractor shall neglect, refuse or fail to complete the remaining Work within the Contract Time or proper extension thereof, if any, granted by Owner, Contractor shall pay Owner the actual costs

reasonably incurred by Owner for engineering and inspection forces employed by Owner relative to the Work for each day that expires after the time specified in Paragraph 4.02.A for Work to be completed and ready for final payment (adjusted for extensions thereof, if any, made in accordance with the General Conditions) until the Work is completed and ready for final payment.

4.05 Owner may deduct liquidated damages and special damages as determined by the provisions of this Article 4 from progress payments due Contractor under this Agreement.

#### **ARTICLE 5 – CONTRACT PRICE**

5.01 Owner shall pay Contractor, in current funds, for completion of the Work in accordance with the Contract Documents the prices stated in Contractor's Bid, which Bid is attached hereto and identified as Exhibit 1 of this Agreement. As provided in the General Conditions, estimated quantities are not guaranteed.

#### **ARTICLE 6 – PAYMENT PROCEDURES**

6.01 Submittal and Processing of Payments

- A. Contractor shall submit Applications for Payment in accordance with the General Conditions. Applications for Payment will be processed as provided in the General Conditions.

6.02 Progress Payments; Retainage

- A. Owner shall make monthly progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment as recommended by Engineer. Contractor's Applications for Payment will be due on the 10<sup>th</sup> day of each month, or as otherwise mutually agreed by Owner and Contractor, during performance of the Work as provided in Paragraph 6.02.A.1. All progress payments will be on the basis of the progress of the Work measured by the Schedule of Values provided for in the General Conditions. A progress payment will not be made whenever the value of the Work completed since the last previous progress payment is less than \$5,000.
- B. Retainage will be held at 5 percent of the progress payment. Half of the retainage shall be released after Substantial Completion, with the remaining half released at Final Completion.
- C. Certified payrolls shall be submitted with each pay estimate.

6.03 Final Payment:

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

**ARTICLE 7 – INTEREST**

- A. No interest will be paid on retainage or withheld payments.

**ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS**

8.01 As part of the inducement for Owner to enter into this Agreement, Contractor makes the following representations:

- A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.
- B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. Contractor is familiar with and is satisfied as to the Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); if any, that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”, and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”.
- E. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on:
  - 1. The cost, progress, and performance of the Work;

2. The means, methods, techniques, sequences and procedures of construction to be employed by Contractor, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents, and;
  3. Contractor's safety precautions and programs.
- F. Based on the information and observations referred to in Paragraph 8.01.E above, Contractor does not consider that further examinations, investigations, explorations, tests, studies or data are necessary for the performance of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents.
- G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
- H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents and the written resolution thereof by Engineer is acceptable to Contractor.
- I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.
- J. 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.

## **ARTICLE 9 – CONTRACT DOCUMENTS**

- 9.01 The Contract Documents consist of the following:
- A. This Agreement
  - B. Performance Bond
  - C. Payment Bond
  - D. Conditions of the Contract
  - E. Volume 1: Specifications, as listed in the table of contents of the Project Manual
  - F. Volume 2: The Drawings bound to the Project Manual, entitled "Dewatering Building HVAC Improvements"

- G. Addenda consisting of number 1 through \_\_\_\_\_, inclusive.
- H. The following, which may be delivered or issued on or after the Effective Date of the Agreement, and are not attached hereto:
  - 1. Notice to Proceed.
  - 2. Work Change Directive(s)
  - 3. Change Order(s)
  - 4. Field Order(s)

9.02 The documents listed in Paragraph 9.01 above are attached to this Agreement (except as expressly noted otherwise above). Documents not attached are incorporated by reference. There are no Contract Documents other than those listed in this Article 9.

9.03 The Contract Documents may only be amended or supplemented as provided in the General Conditions.

## **ARTICLE 10 – MISCELLANEOUS**

### 10.01 Terms

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

### 10.02 Assignment of Contract

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

### 10.03 Successors and Assigns

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



10.04 Severability

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

10.05 Waiver

- A. The waiver by the Owner of any breach or violation of any term, covenant, or condition of this Agreement or of any Law or Regulation shall not be deemed to be a waiver of any other term, covenant, condition, or Law or Regulation, or of any subsequent breach or violation of the same or of any other term, covenant, condition, or Law or Regulation. The subsequent payment of any monies or fee by the Owner which may become due hereunder shall not be deemed to be a waiver of any preceding breach or violation by Contractor of any term, covenant, condition of this Agreement or of any applicable Law or Regulation.

10.06 Contractor's Certifications

- A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 10.06:
  - 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 to:
    - a. influence the bidding process or the execution of the Contract to the detriment of Owner,
    - b. establish Bid or Contract prices at artificial non-competitive levels, or
    - c. 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.

#### 10.07 Government Records Access and Management Act

- A. Contractor recognizes that, as a governmental entity, Owner is subject to the Government Records Access and Management Act, Title 63G, Chapter 2 of the Utah Code ("GRAMA"), and cannot guarantee that information or any document or record provided to Owner will not be subject to disclosure unless it is properly classified as a "protected record" under GRAMA based upon a written claim of business confidentiality under Utah Code Ann §§ 63G-2-305 and -309 and other provisions of GRAMA. For any record to be classified as a "protected record", Contractor must provide a written claim of business confidentiality and a concise statement of reasons and justifications supporting the claim of business confidentiality with the record when it is first submitted by Contractor to Owner and, if not so provided, any claim to protected record status may be deemed to have been waived and relinquished by Contractor.

#### 10.08 Anti-Boycott

- A. Contractor certifies that it is not currently engaged in a boycott of the State of Israel or an economic boycott, as defined in Utah Code Ann. § 638-27-102 and prohibited by Utah Code Ann. § 638-27-201(1); and agrees not to engage in a boycott of the State of Israel for the duration of this Agreement. Furthermore, Contractor agrees to notify the Owner in writing if Contractor begins engaging in a prohibited economic boycott during the term of this Agreement. Activities which are not to be boycotted, absent an ordinary business purpose or unless the boycott is intended to comply with applicable state or federal law, include a boycott of companies that are engaged in fossil fuel-based energy, timber, mining, agriculture, or firearms; companies that do not meet or commit to meet environmental standards beyond applicable state and federal law requirements; or companies that do not facilitate or commit to facilitate access to abortion or sex characteristic surgical procedures. Notwithstanding anything to the contrary stated in this contract, pursuant to Utah Code Ann. § 638-27-201(3), this provision does not apply to a contract with a total value of less than \$100,000 or to a contract with an entity that has fewer than 10 full-time employees, nor prohibit Owner from entering into a contract with an entity that engages in an otherwise prohibited economic boycott if there is no economically practicable alternative available "to (A) acquire or dispose of a good or service; or (B) meet Owner's legal duties to issue, incur, or manage debt obligations, or deposit, keep custody of, manage, borrow, or invest funds" or if the purpose of the economic boycott is to "comply with federal law."

10.09 E-Verify

- A. Contractor covenants, represents and warrants to Owner that Contractor is and at all times during the performance of the Project will be in full compliance with the requirements of Utah Code Ann. § 638-12-302(3) (including amendments and substitutions to the law) relative to the verification of the work eligibility status of employees and, in particular, that Contractor is registered and participates in a Status Verification system as required by law, and will require the same of any subcontractor who may assist Contractor in providing services in connection with the Project.

10.10 Governmental Immunity Act

- A. Contractor understands, acknowledges and agrees that Owner is a political subdivision of the state of Utah and, as such, Owner and its employees is/are entitled to any and all immunity from suit, limitations on judgements, protections and defenses afforded by the Governmental Immunity Act of Utah, Title 63G, Chapter 7 of the Utah Code. Nothing stated in this Agreement or elsewhere is intended, nor shall it be interpreted or construed, to release, alter, waive, or minimize any immunity, limitation, protection or benefit afforded to Owner and/or its employees by the Governmental Immunity Act of Utah.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement on the day and year first written above.

This Agreement will be effective on \_\_\_\_\_, \_\_\_\_\_  
(which is the Effective Date of the Agreement).

Owner: \_\_\_\_\_

Contractor: \_\_\_\_\_

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Title: \_\_\_\_\_

(CORPORATE SEAL)

(CORPORATE SEAL)

Attest \_\_\_\_\_

Attest \_\_\_\_\_

Title: \_\_\_\_\_

Title: \_\_\_\_\_

Address for giving notices

Address for giving notices

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Agent for service of process: \_\_\_\_\_

\_\_\_\_\_  
(Attach evidence of authority to sign and resolution or other documents authorizing execution of

\_\_\_\_\_  
(If Contractor is a corporation, partnership, or limited liability company, attach evidence of authority to sign.)

Hazen and Sawyer  
Agreement.)

Project No.: 70088-001

**END OF AGREEMENT**

**SECTION 00 55 00  
NOTICE TO PROCEED**

To: \_\_\_\_\_ Date: \_\_\_\_\_, 20\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

You are hereby notified to commence Work in accordance with the Agreement dated \_\_\_\_\_, 20\_\_\_\_ on or before \_\_\_\_\_, 20\_\_\_\_. You are to complete the Work in accordance with the milestone schedule in the Agreement. The milestone work activity durations are as stated in the Agreement. Liquidated damages in the amount scheduled per calendar day for each calendar day the Work remains incomplete after its associated milestone date will be imposed unless the Contract Times are otherwise adjusted for due cause by Change Order to the Agreement.

OWNER

\_\_\_\_\_  
By: \_\_\_\_\_  
Title: \_\_\_\_\_

**ACCEPTANCE OF NOTICE**

Receipt of the above Notice to Proceed is hereby acknowledged this

\_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

By: \_\_\_\_\_

Title: \_\_\_\_\_

**END OF NOTICE TO PROCEED**

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**PERFORMANCE BOND**

<p><b>Contractor</b>                  Name:                  Address <i>(principal place of business)</i>:</p>	<p><b>Surety</b>                  Name:                  Address <i>(principal place of business)</i>:</p>
<p><b>Owner</b>                  Name: <b>Central Weber Sewer Improvement District</b>                  Mailing address <i>(principal place of business)</i>:  <b>2618 Pioneer Road</b>  <b>Ogden, UT 84404</b></p>	<p><b>Contract</b>                  Description <i>(name and location)</i>:  <b>Dewatering Building HVAC Improvements</b>                  Ogden, UT                  Contract Price:                  Effective Date of Contract:</p>
<p><b>Bond</b>                  Bond Amount:                  Date of Bond:  <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i>                  Modifications to this Bond form:  <input checked="" type="checkbox"/> None <input type="checkbox"/> See Paragraph 16</p>	
<p>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.</p>	
Contractor as Principal	Surety
_____ <i>(Full formal name of Contractor)</i>	_____ <i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<p><i>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.</i></p>	



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

- 5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:
  - 5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
  - 5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.
7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
  - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
  - 7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
  - 7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
14. Definitions
  - 14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
  - 14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
  - 14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
  - 14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
  - 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows: None

**PAYMENT BOND**

<p><b>Contractor</b>                  Name:                  Address <i>(principal place of business)</i>:</p>	<p><b>Surety</b>                  Name:                  Address <i>(principal place of business)</i>:</p>
<p><b>Owner</b>  <b>Central Weber Sewer Improvement</b>                  Name: <b>District</b>                  Mailing address <i>(principal place of business)</i>:  <b>2618 Pioneer Road</b>  <b>Ogden, UT 84404</b></p>	<p><b>Contract</b>                  Description <i>(name and location)</i>:  <b>Dewatering Building HVAC Improvements</b>                  Ogden, UT                  Contract Price:                  Effective Date of Contract:</p>
<p><b>Bond</b>                  Bond Amount:                  Date of Bond:  <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i>                  Modifications to this Bond form:  <input checked="" type="checkbox"/> None <input type="checkbox"/> See Paragraph 18</p>	
<p>Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.</p>	
<p>Contractor as Principal</p>	<p>Surety</p>
<p><i>(Full formal name of Contractor)</i></p>	<p><i>(Full formal name of Surety) (corporate seal)</i></p>
<p>By: _____  <i>(Signature)</i></p>	<p>By: _____  <i>(Signature)(Attach Power of Attorney)</i></p>
<p>Name: _____  <i>(Printed or typed)</i></p>	<p>Name: _____  <i>(Printed or typed)</i></p>
<p>Title: _____</p>	<p>Title: _____</p>
<p>Attest: _____  <i>(Signature)</i></p>	<p>Attest: _____  <i>(Signature)</i></p>
<p>Name: _____  <i>(Printed or typed)</i></p>	<p>Name: _____  <i>(Printed or typed)</i></p>
<p>Title: _____</p>	<p>Title: _____</p>
<p><i>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.</i></p>	

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





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

## STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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# **GUIDELINES FOR USE OF EJCDC® C-700, STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT**

## **1.0 PURPOSE AND INTENDED USE OF THE DOCUMENT**

EJCDC® C-700, Standard General Conditions of the Construction Contract (2018), is the foundation document for the EJCDC Construction Series. The General Conditions define the basic rights, responsibilities, risk allocations, and contractual relationship of the Owner and Contractor, and establish how the Contract is to be administered.

## **2.0 OTHER DOCUMENTS**

EJCDC documents are intended to be used as a system and changes in one EJCDC document may require a corresponding change in other documents. Other EJCDC documents may also serve as a reference to provide insight or guidance for the preparation of this document.

These General Conditions have been prepared for use with either EJCDC® C-520, Agreement Between Owner and Contractor for Construction Contract (Stipulated Price), or EJCDC® C-525, Agreement Between Owner and Contractor for Construction Contract (Cost-Plus-Fee) (2018 Editions). The provisions of the General Conditions and the Agreement are interrelated, and a change in one may necessitate a change in the other.

To prepare supplementary conditions that are coordinated with the General Conditions, use EJCDC® C-800, Supplementary Conditions of the Construction Contract (2018).

The full EJCDC Construction series of documents is discussed in the EJCDC® C-001, Commentary on the 2018 EJCDC Construction Documents (2018).

## **3.0 ORGANIZATION OF INFORMATION**

All parties involved in a construction project benefit significantly from a standardized approach in the location of subject matter throughout the documents. Experience confirms the danger of addressing the same subject matter in more than one location; doing so frequently leads to confusion and unanticipated legal consequences. Careful attention should be given to the guidance provided in EJCDC® N-122/AIA® A521, Uniform Location of Subject Matter (2012 Edition) when preparing documents. EJCDC® N-122/AIA® A521 is available at no charge from the EJCDC website, [www.ejcdc.org](http://www.ejcdc.org), and from the websites of EJCDC's sponsoring organizations.

If CSI MasterFormat™ is used for organizing the Project Manual, consult CSI MasterFormat™ for the appropriate document number (e.g., under 00 11 00, Advertisements and Invitations), and accordingly number the document and its pages.

## **4.0 EDITING THIS DOCUMENT**

Remove these Guidelines for Use. Some users may also prefer to remove the two cover pages.

Although it is permissible to revise the Standard EJCDC Text of C-700 (the content beginning at page 1 and continuing to the end), it is common practice to leave the Standard EJCDC Text of C-700 intact and unaltered, with modifications and supplementation of C-700's provisions set forth in EJCDC® C-800, Supplementary Conditions of the Construction Contract (2018). If the Standard Text itself is revised, the

user must comply with the terms of the License Agreement, Paragraph 4.0, Document-Specific Provisions, concerning the tracking or highlighting of revisions. The following is a summary of the relevant License Agreement provisions:

1. The term “Standard EJCDC Text” for C-700 refers to all text prepared by EJCDC in the main body of the document. Document covers, logos, footers, instructions, or copyright notices are not Standard EJCDC Text for this purpose.
2. During the drafting or negotiating process for C-700, it is important that the two contracting parties are both aware of any changes that have been made to the Standard EJCDC Text. Thus, if a draft or version of C-700 purports to be or appears to be an EJCDC document, the user must plainly show all changes to the Standard EJCDC Text, using “Track Changes” (redline/strikeout), highlighting, or other means of clearly indicating additions and deletions.
3. If C-700 has been revised or altered and is subsequently presented to third parties (such as potential bidders, grant agencies, lenders, or sureties) as an EJCDC document, then the changes to the Standard EJCDC Text must be shown, or the third parties must receive access to a version that shows the changes.
4. Once the document is ready to be finalized (and if applicable executed by the contracting parties), it is no longer necessary to continue to show changes to the Standard EJCDC Text. The user may produce a final version of the document in a format in which all changes are accepted, and the document at that point does not need to include any “Track Changes,” redline/strikeout, highlighting, or other indication of additions and deletions to the Standard EJCDC Text.

## **5.0 LICENSE AGREEMENT**

This document is subject to the terms and conditions of the **License Agreement, 2018 EJCDC® Construction Series Documents**. A copy of the License Agreement was furnished at the time of purchase of this document, and is available for review at [www.ejcdc.org](http://www.ejcdc.org) and the websites of EJCDC’s sponsoring organizations.

# STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

## TABLE OF CONTENTS

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

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

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



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

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

# 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, expeditors, 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 73 00**  
**SUPPLEMENTARY CONDITIONS**

These Supplementary Conditions amend or supplement Section 00 72 00 General Conditions of the Construction Contract (EJCDC C-700, 2018 edition). The General Conditions remain in full force and effect except as amended. The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, "Paragraph SC 4.05."

**TABLE OF CONTENTS**

Article 1— Definitions and Terminology

Article 2— Preliminary Matters

Article 3— Contract Documents: Intent, Requirements, Reuse

Article 4— Commencement and Progress of the Work

Article 5— Site, Subsurface and Physical Conditions, Hazardous Environmental Conditions

Article 6— Bonds and Insurance

Article 7— Contractor's Responsibilities

Article 8— Other Work at the Site

Article 9— Owner's Responsibilities

Article 10— Engineer's Status During Construction

Article 11— Changes to the Contract

Article 12— Claims

Article 13— Cost of Work; Allowances, Unit Price Work

Article 14— Tests and Inspections; Correction, Removal, or Acceptance of Defective Work

Article 15— Payments to Contractor, Set Offs; Completions; Correction Period

Article 16— Suspension of Work and Termination

Article 17— Final Resolutions of Disputes

Article 18— Miscellaneous

**ARTICLE 1 – DEFINITIONS AND TERMINOLOGY**

**1.01 DEFINED TERMS**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 2 – PRELIMINARY MATTERS**

SC 2.02 Delete Paragraph 2.02.A in its entirety and insert the following in its place:

- A. Owner shall furnish to Contractor one printed copy of the Contract Documents (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Contract Drawings will be printed half size (11 x 17). Additional printed copies will be furnished upon request at the cost of reproduction.

SC 2.02 Add the following new paragraph immediately following Paragraph 2.02.B:

- C. Conformed Contract Documents
  1. Owner will furnish to Contractor conformed Contract Documents incorporating and integrating Addenda and any amendments negotiated prior to the Effective Date of the Contract.
  2. Conformed Contract Documents are not Contract Documents and are provided for convenience for use during the performance of the Work and the administration of the Contract.
  3. Owner will furnish to Contractor one copy printed half size (11 x 17) of the conformed Contract Documents and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction

**ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK**

SC 4.01 Add the following new paragraph immediately after Paragraph 4.01.A:

- B. Commencement of Contract Times limits may be modified by mutual consent of parties of the Contract.

SC 4.05 Amend Paragraph 4.05.C by adding the following subparagraphs:

5. Weather-Related Delays

- a. If “abnormal weather conditions” as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following:
- 1) that weather conditions were abnormal for the period of time in which the delay occurred,
  - 2) that such weather conditions could not have been reasonably anticipated, and
  - 3) that such weather conditions had an adverse effect on the Work as scheduled.
- b. The existence of abnormal weather conditions will not relieve Contractor of the obligation to demonstrate and document that delays caused by abnormal weather are specific to the planned work activities or that such activities thus delayed were on Contractor’s then-current Progress Schedule’s critical path for the Project.
- c. Contractor shall obtain weather history for the most recent five (5) years (minimum) preceding the Notice to Proceed. Weather history shall be obtained from the National Oceanic & Atmospheric Administration (NOAA) [or other source approved by the Engineer]. Historical weather shall be based on data from the weather reporting station closest to the Site.
- d. Contractor shall calculate average days for each month when rainfall and snowfall exceeds historic 90<sup>th</sup> percentile over a 24-hour period based on the historic data. The average monthly rainfall days calculated shall be rounded up to the next full day.

- e. Contractor will be awarded a time extension equal to the number of days that exceed the calculated historical monthly average days for a month.
- f. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with the following:
  - 1) For delays associated with an abnormal amount of rain, Contractor shall use the weather history to calculate an average number of days that rainfall exceeded 90<sup>th</sup> percentile over a 24-hour period starting at 7:00 p.m. on the preceding day through 7:00 p.m. on the workday in question. The Contractor will be awarded a time extension equal to the number of days, above the calculated average, that the period in question experienced rainfall (or rainfall equivalent) in excess of 90<sup>th</sup> percentile. A Contract Time extension will not be awarded for rain amounts less than 90<sup>th</sup> percentile.
  - 4) For 24-hour daily rain amounts, between 7:00 p.m. on the preceding day through 7:00 p.m. on the workday in question, in excess of 1-inch the Contractor shall be awarded one day beyond the number of days calculated as described above. The added day shall be a recovery period for the Contractor to perform Site maintenance, to dewater the Site and to restore erosion control facilities before resuming work.
  - 5) Where the Contractor can demonstrate that the abnormal weather event has impaired his ability to perform work, beyond the day of the abnormal event, a recovery day, or days, to perform Site maintenance as necessary to restore the Site to a workable condition will be awarded. The recovery days may be awarded if requested in writing by the Contractor and approved by the Engineer. Written requests for recovery days shall include a description of Work activities performed during the recovery days.

## **ARTICLE 5 – SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS**

SC 5.03 Add the following new paragraphs immediately after Paragraph 5.03.D:

- E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Date of Report	Technical Data
<b>No reports available</b>		

- F. The following table lists the 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 specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
<b>No drawings available</b>		

SC 5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
<b>No reports available</b>		

5. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and

Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
No drawings available		

**ARTICLE 6 – BONDS AND INSURANCE**

6.03 Contractor’s Insurance

SC 6.03 Supplement Paragraph 6.03 with the following provisions after Paragraph 6.03.C:

- D. Workers’ Compensation and Employer’s Liability: Contractor shall purchase and maintain workers’ compensation and employer’s liability insurance, including, as applicable, United States Longshoreman and Harbor Workers’ Compensation Act, Jones Act, stop-gap employer’s liability coverage for monopolistic states, and foreign voluntary workers’ compensation (from available sources, notwithstanding the jurisdictional requirement of Paragraph 6.02.B of the General Conditions).

Workers’ Compensation and Related Policies	Policy limits of not less than:
<b>Workers’ Compensation</b>	
State	Statutory
Applicable Federal (e.g., Longshoreman’s)	Statutory
Foreign voluntary workers’ compensation (employer’s responsibility coverage), if applicable	Statutory
<b>Jones Act (if applicable)</b>	
Bodily injury by accident—each accident	\$2,000,000
Bodily injury by disease—aggregate	\$2,000,000
<b>Employer’s Liability</b>	
Each accident	\$2,000,000
Each employee	\$2,000,000
Policy limit	\$2,000,000
<b>Stop-gap Liability Coverage</b>	
For work performed in monopolistic states, stop-gap liability coverage must be endorsed to either the worker’s compensation or commercial general liability policy with a	\$2,000,000

<b>Workers' Compensation and Related Policies</b>	<b>Policy limits of not less than:</b>
minimum limit of:	

- E. Commercial General Liability—Claims Covered: Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:
  - 1. damages because of bodily injury, sickness or disease, or death of any person other than Contractor’s employees,
  - 2. damages insured by reasonably available personal injury liability coverage, and
  - 3. damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
  
- F. Commercial General Liability—Form and Content: Contractor’s commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form) and include the following coverages and endorsements:
  - 1. Products and completed operations coverage.
    - a. Such insurance must be maintained for three years after final payment.
    - b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
  - 2. Blanket contractual liability coverage, including but not limited to coverage of Contractor’s contractual indemnity obligations in Paragraph 7.18.
  - 3. Severability of interests and no insured-versus-insured or cross-liability exclusions.
  - 4. Underground, explosion, and collapse coverage.
  - 5. Personal injury coverage.
  - 6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). If Contractor demonstrates to Owner that the specified ISO endorsements



are not commercially available, then Contractor may satisfy this requirement by providing equivalent endorsements.

- 7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04 “Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured” or its equivalent.

G. Commercial General Liability—Excluded Content: The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:

- 1. Any modification of the standard definition of “insured contract” (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).
- 2. Any exclusion for water intrusion or water damage.
- 3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
- 4. Any exclusion of coverage relating to earth subsidence or movement.
- 5. Any exclusion for the insured’s vicarious liability, strict liability, or statutory liability (other than worker’s compensation).
- 6. Any limitation or exclusion based on the nature of Contractor’s work.
- 7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.

H. Commercial General Liability—Minimum Policy Limits

<b>Commercial General Liability</b>	<b>Policy limits of not less than:</b>
General Aggregate	\$2,000,000
Products—Completed Operations Aggregate	\$2,000,000
Personal and Advertising Injury	\$2,000,000
Bodily Injury and Property Damage—Each Occurrence	\$2,000,000

- I. Automobile Liability: Contractor shall purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis.

<b>Automobile Liability</b>	<b>Policy limits of not less than:</b>
<b>Bodily Injury</b>	
Each Person	\$2,000,000
Each Accident	\$2,000,000
<b>Property Damage</b>	
Each Accident	\$2,000,000
<b>[or]</b>	
<b>Combined Single Limit</b>	
Combined Single Limit (Bodily Injury and Property Damage)	\$2,000,000

- J. Umbrella or Excess Liability: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer’s liability, commercial general liability, and automobile liability insurance described in the Paragraphs above. The coverage afforded must be at least as broad as that of each and every one of the underlying policies.

<b>Excess or Umbrella Liability</b>	<b>Policy limits of not less than:</b>
Each Occurrence	\$2,000,000
General Aggregate	\$2,000,000

- K. Using Umbrella or Excess Liability Insurance to Meet CGL and Other Policy Limit Requirements: Contractor may meet the policy limits specified for employer’s liability, commercial general liability, and automobile liability through the primary policies alone, or through combinations of the primary insurance policy’s policy limits and partial attribution of the policy limits of an umbrella or excess liability policy that is at least as broad in coverage as that of the underlying policy, as specified herein. If such umbrella or excess liability policy was required under this Contract, at a specified minimum policy limit, such umbrella or excess policy must retain a minimum limit of \$2,000,000 after accounting for partial attribution of its limits to underlying policies, as allowed above.

6.04 Builder’s Risk and Other Property Insurance

SC 6.04 Supplement Paragraph 6.04 of the General Conditions with the following provisions:

- F. Builder’s Risk Requirements: The builder’s risk insurance must:
  1. be written on a builder’s risk “all risk” policy form that at a minimum includes insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment stored and in transit, and must not exclude the coverage of the following risks: fire; windstorm;

hail; flood; earthquake, volcanic activity, and other earth movement; lightning; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; and water damage (other than that caused by flood).

- a. Such policy will include an exception that results in coverage for ensuing losses from physical damage or loss with respect to any defective workmanship, methods, design, or materials exclusions.
  - b. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake, volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance will be provided through other insurance policies acceptable to Owner and Contractor.
2. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
  3. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of contractors, engineers, and architects).
  4. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
  5. extend to cover damage or loss to insured property while in transit.
  6. allow for the waiver of the insurer's subrogation rights, as set forth in this Contract.
  7. allow for partial occupancy or use by Owner by endorsement, and without cancellation or lapse of coverage.

8. include performance/hot testing and start-up, if applicable.
9. be maintained in effect until the Work is complete, as set forth in Paragraph 15.06.D of the General Conditions, or until written confirmation of Owner's procurement of property insurance following Substantial Completion, whichever occurs first.
10. include as named insureds the Owner, Contractor, Subcontractors (of every tier), and any other individuals or entities required by this Contract to be insured under such builder's risk policy. For purposes of Paragraphs 6.04, 6.05, and 6.06 of the General Conditions, and this and all other corresponding Supplementary Conditions, the parties required to be insured will be referred to collectively as "insureds."

## **ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES**

SC 7.10 Add a new paragraph immediately after Paragraph 7.10.A:

- B. Owner is exempt from payment of sales and compensating use taxes of the State of Utah and of cities and counties thereof on all materials to be incorporated into the Work.
  1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the Work.
  2. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

## **ARTICLE 8 – OTHER WORK AT THE SITE**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

## **ARTICLE 9 – OWNER'S RESPONSIBILITIES**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

## **ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION**

SC 10.03 Add the following new subparagraph immediately after Paragraph 10.03.A:

1. On this Project, by agreement with the Owner, the Engineer will not furnish a Resident Project Representative to represent Engineer at the Site or assist Owner's Site Representative in observing the progress and quality of the Work

**ARTICLE 11 – CHANGES TO THE CONTRACT**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 12 – CLAIMS**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 13 – COST OF THE WORK; CASH ALLOWANCES, UNIT PRICE WORK**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 14 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 15 – PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETION; CORRECTION PERIOD**

SC 15.01 Amend the first sentence of Paragraph 15.01.D.1 by striking out the following words:

“Ten days”

And replace with the following:

“Thirty days”

**ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 17 – FINAL RESOLUTION OF DISPUTES**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**ARTICLE 18 – MISCELLANEOUS**

No modifications to the General Conditions via this Article of the Supplementary Conditions.

**END OF SECTION**

**SECTION 01 11 00  
SUMMARY OF WORK**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Summary
2. Location and Description of Work
3. Construction Contracts, This Project
4. Construction Contracts, Other Projects
5. Work by Others
6. Work by Owner
7. Owner Furnished Equipment and Materials
8. Owner Assigned Procurement Contracts
9. Owner Pre-selected Equipment and Materials
10. Sequence and Progress of Work
11. Contractor's Use of Site
12. Easements and Rights-of-Way
13. Notices to Owners and Authorities of Properties Adjacent to the Work
14. Salvage of Equipment and Materials
15. Partial Utilization by Owner

**1.02 LOCATION AND DESCRIPTION OF WORK**

- A. The Work is located at the following Site:

1. Central Weber Sewer Improvement District, 2618 Pioneer Road, Ogden, UT 84404

B. The Work to be performed under this Contract includes, but is not limited to, constructing the Work described below and all appurtenances related to the Work. The Work shall be as follows:

1. Demolition and removal of the existing HVAC air handling unit and associated duct work.
2. Demolition and removal of existing electrical UPS system and HVAC RIO.
3. Installation of new HVAC air handling unit and duct work.
4. Installation of related HVAC electrical items and control panels.
5. Structural modifications to the existing building for duct work and fan openings.

### **1.03 CONSTRUCTION CONTRACTS, THIS PROJECT**

A. The Contracts under which the Project will be constructed are:

1. Work specified in Divisions 01 through 40 (inclusive) of the Specifications.
2. Work shown on sheets 1 through 53 (inclusive) of the Drawings.

### **1.04 CONSTRUCTION CONTRACTS, OTHER PROJECTS (NOT USED)**

### **1.05 WORK BY OTHERS (NOT USED)**

### **1.06 WORK BY OWNER**

A. Owner will perform the following in connection with the Work: Operate all existing valves, gates, pumps, equipment, and appurtenances that will affect Owner's operation, unless otherwise specified or indicated.

### **1.07 OWNER-FURNISHED EQUIPMENT AND MATERIALS (NOT USED)**

### **1.08 OWNER ASSIGNED PROCUREMENT DOCUMENTS (NOT USED)**

### **1.09 OWNER PRE-SELECTED EQUIPMENT AND MATERIALS (NOT USED)**

### **1.10 SEQUENCE AND PROGRESS OF WORK**



- A. Requirements for sequencing and coordinating with Owner's operations, including maintenance of plant operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 00 – Coordination with Owner's Operations.

#### **1.11 CONTRACTOR'S USE OF SITE**

- A. Contractors' use of the Site shall be confined to the areas shown. Contractors shall share use of the Site with other contractors and others specified in this Section.
- B. Contractor shall move stored products that interfere with operations of Owner, other contractors, or others performing work for Owner.

#### **1.12 EASEMENTS AND RIGHTS-OF-WAY**

- A. Easements and rights-of-way will be provided by Owner in accordance with the General Conditions. Confine construction operations to within Owner's property, public rights-of-way, easements obtained by Owner, and the limits shown. Use care in placing construction tools, equipment, excavated materials, and products to be incorporated into the Work to avoid damaging property and interfering with traffic. Do not enter private property outside the construction limits without permission from the owner of the property.

#### **1.13 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK**

- A. Notify owners of adjacent property and utilities when execution of the Work may affect their property, facilities, or use of property.
- B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Conform notices to Laws and Regulations and, whether delivered orally or in writing, include appropriate information concerning the interruption and instructions on how to limit inconvenience caused.
- C. Notify utility owners and other concerned entities at least 48 hours prior to cutting or closing streets or other traffic areas or excavating near Underground Facilities or exposed utilities.

#### **1.14 SALVAGE OF EQUIPMENT AND MATERIALS**

- A. Existing equipment and materials removed and not shown or specified to be reused in the Work will be Contractor's property, except the following items that shall remain Owner's property:
  - 1. Lamps from light fixtures

2. RIO Panel
  3. Exhaust fan on roof
- B. Existing equipment and material removed by Contractor shall not be reused in the Work, except where specified or indicated.
  - C. Carefully remove in manner to prevent damage all equipment and materials specified or indicated to be salvaged and reused or to remain property of Owner. Store and protect salvaged items specified or indicated to be used in the Work. Replace in kind or with new items equipment, materials, and components damaged in removal, storage, or handling through carelessness or improper procedures.
  - D. Contractor may furnish and install new items, with Engineer's approval, instead of those specified or indicated to be salvaged and reused, in which case such removed items will become Contractor's property.

**1.15 PARTIAL UTILIZATION BY OWNER**

- A. Owner reserves the right to enter and use portions of the Work prior to Certificate of Substantial Completion is issued by Engineer.
- B. Owner shall be responsible to prevent premature connections by private and public parties, persons or groups of persons, before Engineer issues Certificate of Substantial Completion for the portion of Work being partially utilized by Owner.
- C. Contractor shall cooperate with Owner, Owner's agents, and Engineer to accelerate completion of Work designed for partial utilization by Owner in accordance with Contractor's progress schedule.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 14 00**  
**COORDINATION WITH OWNER'S OPERATIONS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Requirements for coordinating with Owner's operations during the Work and included requirements for tie-ins and shutdowns necessary to complete the Work without impact on Owner's operations except as allowed in this Section.
2. Contractor shall provide labor, materials, tools, equipment and incidentals shown, specified and required to coordinate with Owner's operations during the Work.

B. General Requirements:

1. Except for shutdowns specified in this Section, perform the Work such that Owner's facility remains in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede Owner's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, or cause odors or other nuisances.
2. Work not specifically covered in this Section or in referenced Sections may, in general, be completed at any time during regular working hours in accordance with the General Conditions and Supplementary Conditions, subject to the requirements in this Section.
3. Contractor has the option of providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to Owner, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect Owner's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.
4. Coordinate shutdowns with Owner and Engineer. When possible, combine multiple tie-ins into a single shutdown to minimize impacts on Owner's operations and processes.

5. Do not shut off or disconnect existing operating systems, unless accepted by Engineer in writing. Operation of existing equipment will be by Owner unless otherwise specified or indicated. Where necessary for the Work, Contractor shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both. Provide temporary watertight plugs, bulkheads, and line stops as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Engineer.

C. Continuous Treatment Provision:

1. Federal regulations prohibit bypassing of untreated or partially treated wastewater or sewage during construction Work.
2. Contractor shall provide labor, equipment, materials, and incidentals to provide continuous treatment to the level prior to construction Work.
3. Contractor shall be responsible for providing temporary pumping facilities, systems, piping, valve, appurtenances, equipment, materials, and temporary utilities necessary to complete the Work without treatment bypassing.

D. Related Sections:

1. Section 01 11 00 – Summary of Work
2. Section 01 25 00 – Substitution Procedures
3. Section 01 73 00 – Demolition and Execution of Work

## 1.02 REFERENCES

- A. Definitions: A "shutdown" is when a portion of the normal operation of Owner's facility, whether equipment, systems, piping, or conduit, has to be temporarily suspended or taken out of service to perform the Work.

## 1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review installation procedures under other Specification sections and coordinate Work that must be performed with or before the Work specified in this Section.
2. Notify other contractors in advance of Work requiring coordination with Owner's operations, to provide other contractors sufficient time for work included in their contracts that must be installed with or before Work specified in this Section.

3. When possible, combine multiple tie-ins into a single shutdown to minimize impacts on Owner's operations and processes.
- B. Pre-Shutdown Meetings: Contractor shall schedule and conduct meeting with Owner and Engineer prior to scheduling shutdown
- C. Sequencing:
1. Perform the Work in the specified sequence. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed sequence change, with Engineer's acceptance. Stages specified in this Section are sequential in performance of the Work.
- D. Scheduling:
1. Work that may interrupt normal operations shall be accomplished at times convenient to Owner.
  2. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, equipment, spare parts and materials, both temporary and permanent, necessary to successfully complete the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with these requirements before commencing the shutdown.
  3. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.
  4. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not conform to the requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in conducting the Work.
  5. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.
  6. Temporary, short-term shutdowns of smaller piping, conduits, equipment, and systems may be required. Coordinate requirements for such shutdowns with Engineer and Owner.

#### **1.04 SUBMITTALS**

- A. Action/Informational Submittals:

1. **Substitute Sequence Submittal:** When deviation from specified sequence is proposed, provide submittal explaining in detail the proposed sequence change and its effects, including evidence that Owner's operations will not be adversely affected by proposed change. List benefits of proposed sequence change, including benefits to Progress Schedule. Submit in accordance with Section 01 25 00 – Substitution Procedures.
2. **Shutdown Planning Submittal:**
  - a. For each shutdown, submit an inventory of labor and materials required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
  - b. Furnish submittal to Engineer at least thirty (30) days prior to proposed shutdown start date. Do not start shutdown until obtaining Engineer's acceptance of shutdown planning submittal.
3. **Shutdown Notification:** After acceptance of shutdown planning submittal and prior to starting the shutdown, provide written notification to Owner and Engineer of date and time each shutdown is to start. Provide notification at least 72 hours in advance of each shutdown.

## **1.05 SITE CONDITIONS**

- A. **General Constraints:** Specified in the Contract Documents are the sequence and shutdown durations, where applicable, for Owner's equipment, systems, and conduits that are to be taken out of service temporarily for the Work. New equipment, materials, and systems may be used by Owner after the specified field quality controls and testing are successfully completed and the materials or equipment are Substantially Complete.
- B. The following constraints apply to coordination with Owner's operations:
  1. **Operational Access:** Owner's personnel shall have access to equipment and areas that remain in operation.
  2. **Schedule and perform equipment and system start-ups** for Monday through Thursday. Equipment and systems shall not be placed into operation on Friday, Saturday, and Sunday without prior approval of Owner.
  3. **Dead End Valves or Pipe:** Provide blind flanges, watertight bulkheads, or valves at temporary and permanent terminuses of pipes and conduits. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or

otherwise restrained as directed by Engineer. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of pipe or conduit, also provide on downstream side of valve a blind flange with drain/flushing connection.

4. Owner will assist Contractor in dewatering process tanks, basins, conduits, and other work areas to be dewatered for shutdowns. Maintain clean and dry work area by pumping and properly disposing of fluid that accumulates in work areas.
5. Draining and Cleaning of Conduits, Tanks, and Basins: Unless otherwise specified, Owner will dewater process tanks and basins at beginning of each shutdown. Owner will flush and wash down tanks and basins with plant non-potable water. Draining and cleaning conducted by Contractor shall be as specified below:
  - a. Contractor shall remove liquids and solids and dispose of them at appropriate location at the Site as directed by Engineer. Contents of pipes, tanks, basins, and conduits undergoing modifications shall be transferred to existing process tanks or conduits at the Site with capacity sufficient to accept such discharges, using hoses, piping, pumps, or other means provided by Contractor. Discharge of fluids across floors is not allowed.
  - b. If drainage point is not available on the piping or conduit to be drained, provide a wet tap using tapping saddle and valve or other method approved by Engineer. Uncontrolled spillage of pipe's or conduit's contents is not allowed.
  - c. Spillage shall be brought to Engineer's attention immediately, both verbally and in writing, and reported in accordance with Laws and Regulations. Contractor shall wash down spillage to floor drains or sumps and flush the system to prevent clogging and odors. If spillage is not suitable for discharge to the drainage system, such as chemical spills, as determined by Engineer, Contractor shall remove spillage by other method, such as vactor truck, acceptable to Engineer.
6. Electrical, Control, Communication, and Monitoring Systems:
  - a. Owner's existing SCADA system and fiber optic network shall remain functional, subject to the constraints herein.
  - b. Fiber optic communications and network connectivity to the Division Maintenance Building and the Electrical Maintenance Building shall remain operational during the hours of 7:00AM and 5:00PM Monday-Friday.

- c. Unless Contractor elects to use existing fiber and/or temporary fiber, at his/her discretion, at least one communication path through the new dual redundant fiber optic ring to all communication points shall be in place at all times until substantial completion.
- d. Each process area shall be permitted to have a single, non-concurrent, scheduled outage for the purpose of making PLC panel hardware modifications, loading the associated PLC logic, and its field testing/demonstration. Field testing and demonstration shall immediately follow modifications in an effort to keep scheduled shutdowns as short as possible. A 14-day day period of no SCADA outage shall proceed each scheduled shutdown.

#### **1.06 SUGGESTED SEQUENCE OF WORK**

- A. Perform the Work in the specified sequence or as otherwise approved by Engineer. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed sequence change, and with Engineer's acceptance. Stages specified in this Section are sequence-dependent.
  - 1. Stage 1: Coordination of process and building use requirements
  - 2. Stage 2: Installation of temporary heating and ventilation systems
  - 3. Stage 3: Demolition of existing HVAC systems
  - 4. Stage 4: Structural modifications and recoating of structural steel (Bid Alternate)
  - 5. Stage 5: Installation of new HVAC and electrical components
  - 6. Stage 6: Final testing and acceptance
  - 7. Stage 7: Removal of temporary heating and ventilation systems

#### **1.07 TIE-INS**

- A. Coordinate utility tie-ins with owner.

#### **1.08 SHUTDOWNS**

- A. General:



1. Shutdowns shall be limited to a 24 hour duration with a frequency of no more than one shutdown per week.
2. Work that may interrupt normal operations shall be accomplished at times convenient to Owner.
3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, equipment, spare parts and materials, both temporary and permanent, necessary to successfully complete the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with these requirements before commencing the shutdown.
4. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.
5. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not conform to the requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in conducting the Work.

B. Treatment Process Shutdown and Site Access Constraints:

1. Owner shall have the following unit processes and equipment operational at all times during the Project, unless specified herein:
  - a. Filter Presses – A minimum of two (2) presses must be available and accessible at all times.
  - b. Sludge Feed Pumps – A minimum of (2) pumps must be available and accessible at all times.
  - c. Chemical Feed System
  - d. Loadout Garage – Half (1/2) of the loadout garage must be available and accessible at all times.
2. Site Access Constraints:
  - a. Shutdown of the access drives, with exception to the access drive north of the Dewatering Building, shall be limited to one week.
  - b. Owner shall have building access for operations and sludge removal.
  - c. Owner shall have access to all operating equipment.

- C. Shutdowns of Electrical Systems: Comply with Laws and Regulations, including the National Electric Code. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before shutdown Work is started. Upon completion of shutdown Work, remove the locks and tags and notify Engineer that facilities are available for use.
- D. Shutdowns of Communications, SCADA, and Networking:
  - 1. Permissible only if required to tie in new HVAC controls.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

- A. In addition to requirements of this Section, conform to requirements of Section 01 73 00 – Demolition and Execution of Work.

### **3.02 DETAILED SHUTDOWN REQUIREMENTS:**

- A. Prior to Typical Shutdown:
  - 1. Obtain Engineer's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
  - 2. Submittal and approval of all shop drawings required.
  - 3. Coordinate with plant operations on timing of shutdown and provide required notice to Owner.
  - 4. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
  - 5. Assist Owner in preparing to take equipment, tanks, basins, and conduits temporarily out of service.
  - 6. Coordinate other tie-ins to be performed simultaneously.
  - 7. Install and ensure functionality of temporary systems as applicable.
- B. During Typical Shutdown:
  - 1. Owner will dewater tanks and basins.

2. Remove existing equipment, piping, and accessories as required.
3. Verify operation of new equipment, materials, and systems.
4. Following approval from Engineer, return equipment and system to operation with Owner.

C. Following Typical Shutdown:

1. Verify functionality of equipment and system.
2. Verify operation of new equipment and systems, and verify that joints in piping are watertight or gastight as applicable.
3. Repair joints that are not watertight or gastight as applicable.
4. Remove temporary systems as applicable.

**END OF SECTION**

**SECTION 01 25 00  
SUBSTITUTION PROCEDURES**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. Procedural requirements for product substitutions.
  - 2. Procedural requirements for substitute construction methods or procedures, when construction methods or procedures are specified.
- B. Requests for substitutions of equipment and material shall conform to the requirements of the General Conditions and Supplemental Conditions.
- C. Procedure for substitution requests and review including evaluation, reimbursement, acceptance, and determination shall be in accordance with General Conditions and Supplemental Conditions.

**1.02 REFERENCES**

- A. Definitions: The following words or terms are not defined but, when used in this Section, have the following meaning:
  - 1. “Acceptable Manufacturers” considered for substitution include Suppliers of equipment and material of proven reliability, and as manufactured by reputable manufacturers having experience in the production of specified equipment and material. Equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed in accordance with the Contract Documents.
  - 2. “Products” includes materials, equipment, machinery, components, fixtures, systems, and other goods incorporated in the Work. Products do not include machinery and equipment used for preparing, fabricating, conveying, erecting, or installing the Work. Products include Owner-furnished goods incorporated in the Work where use of such goods is specifically required in the Contract Documents.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A. Contractor’s Responsibilities: In submitting request for substitution, Contractor represents that:

1. Contractor has investigated proposed substitution and determined that it is equivalent to item, product, method, or procedure specified, as applicable.
  2. Contractor will provide the same or better guarantees or warranties for proposed substitution as for the specified product, manufacturer, method, or procedure, as applicable.
  3. Contractor waives all Claims for additional costs or extension of time related to proposed substitution that subsequently may become apparent.
  4. Contractor shall submit a minimum of five (5) successful installations of the manufacturer's equipment of the same model, size, and type as specified in the Contract Documents.
- B. Engineer's Review: A proposed substitution will not be accepted for review if:
1. Approval would require changes in design concept or a substantial revision of the Contract Documents.
  2. Approval would delay completion of the Work or the work of other contractors.
  3. Substitution request is indicated or implied on a Shop Drawing or other submittal, or on a request for interpretation or clarification, and is not accompanied by Contractor's formal request for substitution.
  4. If the substitution is not clearly substantiated by performance criteria as providing an equivalent or superior performing installation.
- C. If Engineer does not approve the proposed substitute, Contractor shall provide the specified product, manufacturer, method, or procedure, as applicable.
- D. Approval of a substitution request will not relieve Contractor from requirement for submitting Shop Drawings as set forth in the Contract Documents.
- E. Product Substitutions Procedure:
1. Requests for approval of substitute products or items will be considered for a period of 30 days after the Effective Date of the Agreement. After end of specified period, requests will be considered only in case of unavailability of a specified product or other conditions beyond Contractor's control.
  2. Submit copies of request for substitution.
  3. Submit separate request for each substitution.

4. In addition to requirements of the General Conditions and information required on substitution request forms, include with request the following:
  - a. Product identification, including manufacturer's name and address.
  - b. Manufacturer's literature with product description, performance and test data, and reference standards with which product complies.
  - c. Samples, if appropriate.
  - d. Name and address of similar projects on which product was used, and date of installation.
  - e. Certified tests, where applicable, by an independent laboratory attesting the proposed substitution is equal.
  - f. Cost information for the proposed substitution and the specified products.
  - g. Lead time information for the proposed substitution and specified products.
  - h. All other submittal requirements indicated in the individual Specification Sections associated with the specified equipment and material.
5. Where construction methods or procedures are specified, for a period of 30 days after the Effective Date of the Agreement, Engineer will consider Contractor's written requests for substitute construction methods or procedures specified.
6. Submit copies of request for substitution.
7. Submit separate request for each substitution.
8. In addition to requirements of the General Conditions and information required on substitution request forms, include with request the following:
  - a. Detailed description of proposed method or procedure.
  - b. Itemized comparison of the proposed substitution with the specified method or procedure.
  - c. Drawings illustrating method or procedure.
  - d. Other data required by Engineer to establish that proposed substitution is equivalent to specified method or procedure.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 31 19**  
**PROJECT MEETINGS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Pre-Construction Meeting:
  - a. Purpose of conference is to designate responsible personnel, establish working relationships, discuss preliminary schedules submitted by Contractor, and review administrative and procedural requirements for the Project. Matters requiring coordination will be discussed and procedures for handling such matters will be established.
  - b. Date, Time and Location: Conference will be held after execution of the Contract and before Work starts at the Site. Engineer will establish the date, time, and location of conference and notify the interested and involved parties.
2. Progress Meetings:
  - a. Progress meetings will be held throughout the Project. Contractor shall attend each progress meeting prepared to discuss in detail all items on the agenda.
  - b. Engineer will preside at progress meetings and will prepare and distribute minutes of progress meetings to all meeting participants and others as requested.
  - c. Date, Time and Location:
    - 1) Regular Meetings: Every month on a day and time agreeable to Owner, Engineer, and Contractor.
    - 2) Engineer's Field Office at the Site or other location mutually agreed upon by Owner, Contractor, and Engineer.
  - d. Additional meetings may be conducted as progress of Work requires at a mutually agreed date, time and location.



## 1.02 ADMINSTRATIVE REQUIREMENTS

### A. Pre-Construction Meeting:

1. Contractor shall provide pre-construction meeting submittals with sufficient number of copies for each attendee:
2. Required Attendees:
  - a. Contractor
    - 1) Project manager.
    - 2) Site superintendent.
    - 3) Safety representative.
    - 4) Major Subcontractors.
      - a) HVAC
  - b. Owner.
  - c. Engineer.
  - d. Resident Project Representative (RPR).
  - e. Representatives of governmental or other regulatory agencies.
3. Contractor shall prepare and submit a health and safety plan, including confined space entry plan, as specified in this Section prior to the pre-construction meeting.
4. Agenda, minimum:
  - a. Procedural requirements:
    - 1) Designation of responsible personnel
    - 2) Use of Site and Owner's requirements, including general regards for community relations
    - 3) Delivery of materials and equipment to the Site
    - 4) Safety and first aid procedures

- 5) Confined space entry plan
- 6) Security procedures
- 7) Housekeeping procedures
- b. Administrative requirements:
  - 1) Distribution of Contract Documents.
  - 2) Shop Drawing submittal procedures.
  - 3) Maintaining record documents at the Site.
  - 4) Contract modification procedures
  - 5) Processing of Payment Application
- c. Site mobilization requirements:
  - 1) Working hours, overtime, and holidays.
  - 2) Field offices, trailers, and staging areas.
  - 3) Temporary facilities and utilities, including usage and coordination.
  - 4) Temporary controls, such as sediment and erosion control, noise, dust, storm water, and other measures.
  - 5) Access to Site, access roads, and parking for construction vehicles.
  - 6) Protection of traffic and existing property, including site barriers and temporary fencing.
  - 7) Security
  - 8) Storage of materials and equipment.
  - 9) Reference points and benchmarks, surveys and layouts.
  - 10) Site maintenance during the project, including cleaning and removal of trash and debris.
  - 11) Site restoration.
- d. Schedules

- 1) Preliminary construction schedule
- 2) Critical work sequencing
- 3) Preliminary Shop Drawing submittal schedule
- 4) Preliminary Schedule of Values

B. Progress Meetings:

1. Progress meetings frequency shall be conducted as specified in this Section, unless modified and agreed upon by Owner, Contractor, and Engineer. Additional meetings may be conducted as progress of Work requires.
2. Contractor shall provide submittals specified in this Section prior to each progress meeting.
3. Attendance:
  - a. Contractor, including project manager, site superintendent, safety representative, and representatives of Subcontractors and Suppliers as required.
  - b. Engineer, including project manager (or designated representative), Resident Project Representative (if any), others as required by Engineer.
  - c. Owner, including Owner's Site Representative (if any).
  - d. Subcontractors, only with Engineer's approval or request, as required in the agenda.
4. Agenda, minimum:
  - a. Review, comment, and amendment (if required) of minutes of previous progress meeting.
  - b. Review of progress since the previous progress meeting.
  - c. Planned progress through next 30 – 60 days.
  - d. Review of Progress Schedule
    - 1) Contract Times, including Milestones (if any)
    - 2) Critical path.
    - 3) Schedules for fabrication and delivery of materials and equipment.

- 4) Corrective measures, if required.
- e. Submittals:
  - 1) Review of status of critical submittals.
  - 2) Review revisions to schedule of submittals.
- f. Contract Modifications:
  - 1) Requests for interpretation
  - 2) Clarification notices
  - 3) Field Orders
  - 4) Proposal requests
  - 5) Change Proposals
  - 6) Work Change Directives.
  - 7) Change Orders.
  - 8) Claims.
- g. Applications for progress payments.
- h. Problems, conflicts, and observations.
- i. Quality standards, testing, and inspections.
- j. Coordination between parties.
- k. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.
- l. Safety.
- m. Permits.
- n. Record documents status.
- o. Punch list status, as applicable.
- p. Other business.

### 1.03 SUBMITTALS

#### A. Pre-Construction Meeting Submittals:

1. Prior to the conference, submit the following preliminary schedules in accordance with the General Conditions:
  - 1) Progress schedule
  - 2) Schedule of submittals
  - 3) Schedule of values
2. Contractor's safety and first aid procedures.
3. Confined space entry plan.
4. List of emergency contact information

#### B. Progress Meeting Submittals:

1. List of Work accomplished since the previous progress meeting.
2. Up-to-date Progress Schedule.
3. Up-to-date Schedule of Submittals.
4. Detailed "look-ahead" schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the Owner, Project, and Site.
5. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

### 1.04 EMERGENCY CONTACT INFORMATION

- A. Contractor shall provide list of emergency contact information for 24-hour use throughout the Project. Emergency contact information shall be updated and kept current throughout the Project. If personnel or contact information change, provide updated emergency contact information list at the next progress meeting.
- B. Contractor's list of emergency contact information shall include:
  1. Contractor's project manager's office, field office, cellular, and home telephone numbers.

2. Contractor's Site superintendent's office, field office, cellular, and home telephone numbers.
3. Contractor's foreman's field office, cellular (if available), and home telephone numbers.
4. Major Subcontractors' and Suppliers' office, cellular, and home telephone numbers of project manager and foreman (when applicable).

C. Additional Emergency Contact Information:

1. Owner's Project Manager: office, cellular, and home telephone numbers.
2. Owner's central 24-hour emergency telephone number.
3. Engineer's project engineer's office, cellular, and home telephone numbers.
4. Resident Project Representative's office, field office, cellular, and home telephone numbers.
5. Emergency telephone numbers, including: "Emergency: Dial 911", and seven-digit telephone numbers for the hospital, ambulance, police, and fire department nearest to the Site. Provide names of each of these institutions.
6. Other involved entities as applicable.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 33 00**  
**SUBMITTAL PROCEDURES**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section includes:

1. Contractor shall provide submittals in accordance with the General Conditions as modified by the Supplementary Conditions, and this Section.
2. Contractor is responsible to confirm and correct dimensions at the Site, for information pertaining to the fabrication processes and to techniques of construction, and for coordinating the work of all trades. Contractor's signature of submittal's stamp and letter of transmittal shall be Contractor's representation that Contractor has met their obligations under the Contract Documents relative to that submittal.

B. Related Sections:

1. Section 01 25 00 – Substitution Procedures.
2. Section 01 78 23 – Operation and Maintenance Data.
3. Section 01 78 39 – Project Record Documents.
4. Section 01 78 43 – Spare Parts and Extra Material.
5. Section 01 79 00 – Instruction of Owner's Personnel.

**1.02 ADMINISTRATIVE REQUIREMENTS**

A. Types of Submittals: When type of submittal is not specified and is not specified in this Section, Engineer will determine type of submittal.

1. Action/Informational Submittals:

- a. Shop Drawings.
- b. Product data.
- c. Delegated design submittals in accordance with the General Conditions and as modified by the Supplemental Conditions.

- d. Samples.
  - e. Testing plans, procedures, and testing limitations.
  - f. Design data not sealed and signed by a design professional retained by Contractor, Subcontractor, or Supplier.
  - g. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, potential Hazardous Environmental Conditions, and similar reports.
  - h. Supplier instructions, including installation data, and instructions for handling, starting-up, and troubleshooting.
  - i. Sustainable design submittals (other than sustainable design closeout documentation).
  - j. Lesson plans for training and instruction of Owner's personnel.
2. Closeout Submittals:
- a. Maintenance contracts.
  - b. Operations and maintenance data.
  - c. Bonds, such as maintenance bonds and bonds for a specific product or system.
  - d. Warranty documentation.
  - e. Record documentation.
  - f. Sustainable design closeout documentation.
  - g. Software.
3. Maintenance Material Submittals:
- a. Maintenance materials schedule and checklist.
  - b. Spare parts.
  - c. Extra stock materials.
  - d. Tools.
4. Quality Assurance Submittals:



- a. Performance affidavits.
- b. Certificates.
- c. Source quality control submittals (other than testing plans, procedures, and testing limitations), including results of shop testing.
- d. Field or Site quality control submittals (other than testing plans, procedures, and testing limitations), including results of operating and acceptability tests at the Site.
- e. Supplier reports.
- f. Special procedure submittals, including health and safety plans and other procedural submittals.
- g. Qualifications statements.

B. Submittal Requirements:

1. Contractor shall submit electronic copy of submittals for Engineer's review via SharePoint, unless otherwise specified in individual Specification Sections. Acceptable electronic formats are Adobe PDF, Microsoft Word, Autodesk DWF and AutoCAD.
2. Submittal shall be accompanied by letter of transmittal containing date, project title, Contractor's name, number and title of submittal, list of relevant Specification Sections, notification of deviations from Contract Documents, and other material required for Engineer's review.
3. Submittals with internet hyperlinks and other references to online content shall not be considered, reviewed, and included as part of the submittal review procedure. Hyperlinks and other electronic references shall not be used to comply with specified requirements of the Contract Documents, unless specifically stated in the individual technical Specification Section.

C. Scheduling:

1. Provide submittals well in advance of the Work following Engineer's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents..
2. Submittals shall be provided by Contractor with at least thirty (30) working days for review and processing.

### 1.03 SCHEDULE OF SUBMITTALS

#### A. Schedule of Submittals, as specified in this Section:

1. Timing:
  - a. Provide submittal within time frames specified in the Contract Documents.
  - b. Provide updated Schedule of Submittals with each submittal of the updated Progress Schedule.
2. Content: In accordance with the General Conditions as modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent submittals of the Schedule of Submittals are identical.
  - a. Identify submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path.
  - b. Indicate the following for each submittal:
    - 1) Date when submittals are requested and received from Supplier.
    - 2) Date when certification is received from Supplier and when submitted to Engineer.
    - 3) Date when submittals are submitted to Engineer and returned with disposition from Engineer.
    - 4) Date when submittals are revised by Supplier and submitted to Engineer.
    - 5) Date when submittals are returned with "Furnish as Submitted" (FAS) or "Furnish as Corrected" (FAC) disposition from Engineer.
    - 6) Date when approved submittals are returned to Supplier.
    - 7) Date of Supplier scheduled delivery of equipment and material.
    - 8) Date of actual delivery of equipment and material.
    - 9) Whether submittal will be for a substitution or "equal". Procedures for substitutions and "or equals" are specified in the General Conditions and the Section 01 25 00 – Substitution Procedures.

- 10) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors.
3. Prepare Schedule of Submittals using same software, and in same format, specified for Progress Schedules.
4. Coordinate Schedule of Submittals with the Progress Schedule.
5. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate submittals on the Project's critical path, or that places extraordinary demands on Engineer for time and resources, is unacceptable. Do not include submittals not required by the Contract Documents.
6. In preparing Schedule of Submittals:
  - a. Considering the nature and complexity of each submittal, allow sufficient time for review and revision.
  - b. Reasonable time shall be allowed for: Engineer's review and processing of submittals, for submittals to be revised and resubmitted, and for returning submittals to Contractor.
  - c. Identify and accordingly schedule submittals that are expected to have long anticipated review times.

#### **1.04 ACTION/INFORMATIONAL SUBMITTALS**

- A. Provide the following Submittals in accordance with the individual Specification Sections, including, but not limited to, the following:
  1. Product Data:
    - a. Catalog cut-sheets
    - b. Descriptive bulletins/brochures/specifications
    - c. Material of construction data, including details on all components including applicable ASTM designations.
    - d. Lifting, erection, installation, and adjustment instructions, and recommendations.
    - e. Finish/treatment data, including interior and exterior shop coating systems.

- f. Equipment/material weight/loading data, including total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations following installation. Size, placement, and embedment requirements of anchor bolts.
  - g. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.
  - h. Motor data including horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full load; slip at full load; running, full load, and locked rotor current values; safe running time-current curves; motor protective devices; and interconnection diagrams.
  - i. Engineering design data, calculations, and system analyses
  - j. Digital system documentation
  - k. Operating sequence descriptions
  - l. Software/programming documentation
  - m. Manufacturer's instructions
2. Shop Drawings:
- a. Equipment and material layout drawings, including panel layout drawings.
  - b. System schematics and diagrams including, but not limited to, piping systems; HVAC and ventilation systems; process equipment systems; electrical operating systems; wiring diagrams; controls, alarm and communication systems.
  - c. Layout and installation drawings (interior and exterior) for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc.
  - d. Layout and installation drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.

- e. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.
  - f. Drawings for pipes, ducts, conduits, etc., shall show all 3 inch and larger electrical conduits and pressure piping, electrical cable trays, heating and ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.
  - g. Equipment and material schedules.
3. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by Contractor, Subcontractor, or Supplier for materials and equipment to be incorporated into the completed Work. Delegated design submittals do not include submittals related to temporary construction unless specified otherwise in the related Specification Section. Delegated design submittals include: design drawings, design data including calculations, specifications, certifications, and other submittals prepared by such design professional.

B. Samples:

- 1. General Requirements:
  - a. Conform submittal of Samples to the General Conditions as modified by the Supplementary Conditions, this Section, and the Specification Section in which the Sample is specified.
  - b. Furnish at the same time Samples and submittals that are related to the same unit of Work or Specification Section. Engineer will not review submittals without associated Samples and will not review Samples without associated submittals.
  - c. Samples shall clearly illustrate functional characteristics of product, all related parts and attachments, and full range of color, texture, pattern, and material.
- 2. Submittal Requirements:
  - a. Securely label or tag Samples with submittal identification number. Label or tag shall not cover, conceal, or alter appearance or features of Sample. Label or tag shall not be separated from the Sample.
  - b. Submit number of Samples required in Specifications. If number of Samples is not specified in the associated Specification Section, provide at least one

identical Samples of each item required for Engineer's approval. If Contractor requires Sample(s) for Contractor's use, notify Engineer in writing and provide additional Sample(s). Contractor is responsible for furnishing, shipping, and transporting additional Samples.

- c. Deliver one Sample to Engineer's field office at the Site. Deliver balance of Samples to location directed by Engineer.

#### **1.05 CLOSEOUT SUBMITTALS**

- A. Provide the following Closeout Submittals in accordance with the individual Specification Sections, including, but not limited to, the following:
  1. Maintenance contracts
  2. Bonds for specific products or systems
  3. Warranty documentation
  4. Sustainable design closeout documentation.
  5. Software programming and documentation.
- B. On documents such as maintenance contracts and bonds, include on each document furnished original signature of entity issuing the document.
- C. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 – Operations and Maintenance Data.
- D. Record Documentation: Submit in accordance with Section 01 78 39 – Project Record Documents.
- E. Disposition: Dispositions and meanings are the same as specified for Informational Submittals.

#### **1.06 MAINTENANCE MATERIAL SUBMITTALS**

- A. For spare parts, extra stock materials, and tools, submit quantity of items specified in associated Specification Section. Furnish in accordance with Section 01 78 43 – Spare Parts and Extra Materials.
- B. Disposition: Dispositions and meanings are the same as specified for Informational Submittals.

## 1.07 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall review, coordinate, and verify submittals with Subcontractors, Manufacturers, and Suppliers, including field measurements at Site, in accordance with the General Conditions and as modified by Supplemental Conditions prior to submitting material for Engineer's review.
- B. Contractor shall clearly and concisely indicate and mark equipment and material being submitted to meet the intent of the Contract Documents. Equipment and material not being submitted shall be deleted, stricken through, or otherwise designated not being submitted. Equipment and material data sheets shall be included once with cross references throughout the submittal. Multiple equipment and material data sheets for the same item within a submittal may receive a rejected disposition until corrected.
  - 1. Individual Specification Sections require a Compliance, Deviations, and Exceptions (CD&E) letter to be included with the submittal. When specified, submittals provided without the CD&E letter shall receive a rejected disposition without review.
  - 2. CD&E letter requirements:
    - a. Include a copy of entire Specification section with each paragraph and subparagraph noted with "C", "D", or "E" to indicate if equipment and material being provided is in compliance (C), deviates (D), or exceptions (E) are taken with the Contract Documents.
      - 1) Compliance (C): Full compliance with the specified requirement.
      - 2) Deviation (D): Deviation from the specified requirement.
      - 3) Exception (E): Exception with the specified requirement.
    - b. Include all comments, deviations and exceptions taken to the Contract Documents by the Contractor and Equipment Manufacturer/Supplier.
    - c. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable.
    - d. Address deviations and exceptions taken to each Contract Drawing related to the Specification section.
- C. Contractor shall provide Contractor's stamp of approval certifying submittal material has been reviewed and conform to the Contract Documents prior to submitting material for Engineer's review.

- D. Contractor shall provide written notice of deviations or variations that submittal may have with the Contract Documents.
- E. Contractor shall provide bound, dated, labeled, tabulated, and consecutively numbered submittals as specified in the individual Specification Section. Label shall contain the following:
  - 1. Specification Section.
  - 2. Referenced Drawing number.
  - 3. Subcontractor or Supplier name.
  - 4. Type of equipment and/or materials.
- F. Contractor shall perform the following after receiving Engineer's review disposition:
  - 1. Order, fabricate, or ship equipment and materials included in the submittal (pending Engineer's review of source quality control submittals) with the following disposition:
    - a. "Furnish as Submitted" (FAS).
    - b. "Furnish as Corrected" (FAC).
    - c. "Furnish as Corrected – Confirm" (FACC), only portions of Work that do not require resubmittal for Engineer's review.
  - 2. Resubmittal requirements:
    - a. Partial resubmittal of "Furnish as Corrected – Confirm" (FACC) returned dispositions, until Engineer's disposition is either "Furnish as Submitted" (FAS) or "Furnish as Corrected" (FAC).
    - b. Full resubmittal of material with Engineer's disposition of "Revise and Resubmit" (R&R), until Engineer's disposition is "Furnish as Submitted" (FAS), "Furnish as Corrected" (FAC), or "Furnish as Corrected – Confirm" (FACC) that requires a partial resubmittal.
    - c. Contractor shall be responsible for Engineer's charges to Owner if submittals are not approved within the number of specified submittals in accordance with the General Conditions. Engineer's charges shall include, but not limited to, additional review effort, meetings, and conference calls with Contractor, Subcontractor, or Supplier.



## 1.08 ENGINEER'S REVIEW

- A. Engineer's review of the Contractor's submittal shall not relieve Contractor's responsibility under the Contract Document in accordance with the General Conditions and as modified in the Supplemental Conditions. An acceptance of a submittal shall be intended to mean the Engineer does not have specific objection to the submitted material, subject to conformance with the Contract Drawings and Specifications.
- B. Engineer's review of Contractor's submittal shall be confined to general arrangement and compliance with the Contract Documents, and shall not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of Subcontractor work, etc..
- C. Review Dispositions:
1. "Furnish as Submitted" (FAS) – No exceptions are taken.
  2. "Furnish as Corrected" (FAC) – Minor corrections are noted for Contractor's correction.
  3. "Furnish as Corrected – Confirm" (FACC) – Corrections are noted and partial resubmittal shall be made as noted.
  4. "Revise and Resubmit" (R&R) – Corrections are noted and complete resubmittal shall be made. Submittal does not conform to applicable requirements of the Contract Documents and is not acceptable. Revise submittal and re-submit to indicate acceptability and conformance with the Contract Documents.
  5. "Receipt Acknowledged" (RA) –
    - a. Information included in submittal conforms to the applicable requirements of the Contract Documents and is acceptable. No further action by Contractor is required relative to this submittal, and the Work covered by the submittal may proceed, and products with submittals with this disposition may be shipped or operated, as applicable.
    - b. Information included in submittal is for Project record purposes and does not require Engineer's review or approval.
  6. "Rejected" (R) – Information included in submittal does not conform to the applicable requirements of the Contract Documents and is unacceptable. Contractor shall submit products and materials as specified in the Contract Documents or provide required information for substitution as specified in the Contract Documents for consideration by Engineer.

- D. Electronic Submittal Return to Contractor: Electronic submittals shall be returned electronically with dispositions provided.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 45 33**  
**SPECIAL INSPECTIONS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. This Section defines the requirements for Special Inspections as required by Section 1704 of the International Building Code (IBC) and any State or local amendments.
- B. Either the Engineer of Record (EOR) or Registered Design Professional in Responsible Charge (RDPIRC) will prepare a Statement of Special Inspections, which identifies the type and extent of required Special Inspections.
- C. The Owner will retain one or more Special Inspections Agencies to perform Special Inspection services. These Agencies shall be independent from the Contractor and approved by the Building Official. The EOR may perform Special Inspection services where qualifications for a specific inspection task are met.
- D. The Contractor shall plan and conduct operations as to schedule and allow Special Inspections, providing adequate time and safe access for inspections. The Contractor shall coordinate requirements for Special Inspections with the Special Inspections Agency.
- E. Special Inspections shall be in addition to inspections performed by Building Officials that are specified in IBC Section 104.
- F. Special Inspections shall be in addition to any Structural Observations required by IBC Section 1704.6.
- G. Special Inspections do not supersede other inspections and testing required by the Contract Documents to satisfy the Contractor's quality control responsibility. Contractor shall be responsible for all costs associated with quality control requirements as required by other Sections of the Specifications.
- H. Special Inspections shall not relieve Contractor's obligation to perform and complete work in accordance with Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- I. This Section does not apply to construction equipment, shoring, earth retention systems, and temporary structures used by the Contractor in construction and not detailed in the Contract Documents. The Contractor shall be solely responsible for means, methods, techniques, sequences, or procedures of construction and any associated building code

requirements.

## **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Special Inspections requirements apply to work detailed in other Sections of the Specifications. Special Inspections requirements shall be in addition to any other inspection or quality control requirements detailed in other Sections of the Specifications. See individual Specification Sections for type of work in question.

## **1.03 DEFINITIONS**

- A. Periodic Special Inspections: The part-time or intermittent observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.
- B. Continuous Special Inspections: The full-time observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work is being performed.
- C. Engineer of Record (EOR): The engineer of each system in responsible charge for the design of each specific building system including structural, mechanical, electrical, and architectural components
- D. Registered Design Professional in Responsible Charge (RDPIRC): The RDPIRC in charge of Special Inspections during construction for each specific building system including structural, mechanical, electrical, and architectural components. The RDPIRC shall be a currently Registered Professional Engineer in the State or Commonwealth in which the project is located. The EOR may serve in this role.
- E. Special Inspections Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The EOR may serve in this role where qualifications for specific inspection tasks are met.
- F. Special Inspector: Individual employed by or retained by the Special Inspections Agency who is qualified in inspection of specific aspects or components of the construction and conducts inspection activities in these specific aspects of the construction, as required by this Section. The EOR may serve in this role where qualifications for specific inspection tasks are met.
- G. Statement of Special Inspections: Document prepared by the EOR or RDPIRC and submitted to the Building Official which identifies the type and extent of required Special Inspections.

- H. Approved Fabricator: Fabricator who has been registered and approved by the Building Official to manufacture or fabricate specific components of the construction without Special Inspections.

#### **1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents and all other documents referenced in the Specifications. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. International Building Code
  - 2. ACI 318 – Building Code Requirements for Structural Concrete
  - 3. TMS 402/TMS 602 – Building Code for Masonry Structures/Specifications for Masonry Structures
  - 4. AISC – Code of Standard Practice
  - 5. AISC 341 – Seismic Provisions for Structural Steel Buildings
  - 6. AISC 360 – Specification for Structural Steel Buildings
  - 7. AISC 348 – Specification for Structural Joints Using High Strength Bolts
  - 8. AWS – Structural Welding Code
  - 9. ADMI – Aluminum Design Manual: A Specification for Aluminum Structures

#### **1.05 SUBMITTALS**

- A. The Contractor shall submit the following in accordance with Section 01 33 00 - Submittal Procedures.
  - 1. The Contractor shall submit a written statement of responsibility to the Building Official and RDPIRC prior to beginning work. A statement is required from each Contractor who has responsibility for construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections.
  - 2. The Contractor shall submit qualifications of any fabricators they intend to use that may qualify as Approved Fabricators to the Special Inspections Agency for review.
- B. The Special Inspections Agency shall submit the following in accordance with Section 01 33 00 – Submittal Procedures.

1. The Special Inspections Agency shall provide a statement of qualifications showing relative experience, training, and certification(s) for each Special Inspector to the Building Official, if requested.
2. The Special Inspections Agency shall review fabricator qualifications and submit them to the Building Official for approval as an Approved Fabricator if requested.
3. Special Inspectors shall keep detailed inspection records, including all inspections, tests, similar services, and any discrepancies and corrections. Any discrepancies and corrections shall be reported to the Building Official, the EOR, and the RDPIRC in all required reports, unless otherwise required by the Building Official.
4. The Special Inspections Agency shall submit Interim Reports to the Building Official and the RDPIRC documenting required Special Inspections and correction of any discrepancies at the frequency specified in the Statement of Special Inspections.
5. The Special Inspections Agency shall submit to the Building Official and the RDPIRC a Final Report documenting required Special Inspections and correction of any discrepancies. The Final Report shall be submitted at a point in time agreed upon by the Owner and the Building Official at the Pre-inspection Meeting.
6. Where work is done by Approved Fabricators, the Special Inspections Agency shall coordinate the submittal of a certificate of compliance to the Building Official, the EOR, and the RDPIRC.

#### **1.06 SPECIAL INSPECTOR QUALIFICATIONS**

- A. Special Inspectors shall meet minimum qualifications established by the Building Official and shall be approved by the Building Official.

#### **1.07 OFF-SITE FABRICATIONS**

- A. When structural elements or assemblies are fabricated off site, Special Inspections shall be performed in the fabricator's shop unless the fabricator is an Approved Fabricator. Special Inspections are not required if work is done on the premises of an Approved Fabricator.
- B. Fabricators shall maintain detailed fabrication and quality control procedures to ensure workmanship and conformance with Contract Documents and reference standards. The Special Inspections Agency shall review the fabricator's quality control procedures and coordinate required Special Inspections with the fabricator and the Contractor.
- C. The Contractor shall submit qualifications of fabricators seeking Approved Fabricator status to the Special Inspections Agency for review. Approval as an Approved Fabricator shall be given by the Building Official upon the recommendation of the Special

Inspections Agency or upon review of the fabricator's written fabrication procedures and quality control manuals that provide a basis for control of materials and workmanship, with periodic auditing of fabrication and quality control practices by an Approved Agency or the Building Official.

- D. At completion of fabrication, the Approved Fabricator shall submit a certificate of compliance to the Owner or the RDPIRC for submittal to the Building Official stating that the work was performed in accordance with the approved Contract Documents.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION**

### **3.01 PRE-INSPECTION MEETING**

- A. At least two weeks prior to beginning work, a Pre-inspection Meeting shall be held to discuss the Special Inspection procedures and submittals. The following parties shall participate: EOR, RDPIRC, Special Inspections Agency representative, Contractor, Subcontractors, Testing Agencies, and Building Official. The type of meeting (in-person or teleconference) and location of meeting shall be determined by the Building Official.

### **3.02 STATEMENT AND SCHEDULE OF SPECIAL INSPECTIONS**

- A. The Special Inspections Agency and all Special Inspectors are required to comply with all requirements of the Statement of Special Inspections and the Schedule of Special Inspections. Together, these documents identify materials, systems, components, and work that are required to have Special Inspections, the type and extent of Special Inspections, and whether they will be continuous or periodic. The Schedule of Special Inspections is included at the end of this Section. A form which may be used for the Statement of Special Inspections is also included at the end of this Section.

### **3.03 SPECIAL INSPECTIONS AGENCY REQUIREMENTS AND RESPONSIBILITIES**

- A. The Special Inspections Agency shall be an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The Agency shall demonstrate competence, to the satisfaction of the Building Official, for the inspection of the specific aspects of construction or operation requiring Special Inspection.
- B. The Special Inspections Agency shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Agency shall submit all required reports to the EOR, RDPIRC and Building Official. Where EOR approval is required for corrections, the

Special Inspector shall maintain copies of all related correspondence and submit with all required reports. The Agency shall coordinate all required Special Inspection activities with the Special Inspectors, the Contractor, and any fabricators and shall coordinate designation of fabricators as Approved Fabricators when requested.

### **3.04 SPECIAL INSPECTORS' REQUIREMENTS AND RESPONSIBILITIES**

- A. All Special Inspectors shall meet the qualification requirements determined by the Building Official for the specific type of inspection services they will be providing and shall be approved by the Building Official. Special Inspectors shall submit written documentation demonstrating their competence and experience or training to the Building Official for approval of their qualifications.
- B. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC, or the Building Official. Special Inspectors shall submit all required reports to the RDPIRC and the Building Official. Where EOR approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all required reports. Special Inspectors shall coordinate inspection requirements and time when inspections can be conducted with the Contractor.
- C. Any discrepancies in work noted by the Special Inspector shall be brought to the immediate attention of the Contractor for correction. Special Inspectors shall coordinate correction of discrepancies with the Contractor. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. If noted discrepancies are not corrected, the Special Inspector shall notify the Contractor, the EOR, the RDPIRC and the Building Official. All noted discrepancies and corrections shall be documented in all inspection records and all required reports.

### **3.05 CONTRACTOR RESPONSIBILITIES**

- A. Each Contractor responsible for the construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections shall submit a Statement of Responsibility to the Building Official, RDPIRC, and EOR prior to the commencement of work. The Statement of Responsibility shall contain acknowledgement of the specific requirements contained in the Statement of Special Inspections.
- B. The Contractor shall coordinate requirements of Special Inspections with the Special Inspections Agency and the Special Inspectors and shall provide adequate time and access to conduct inspections. The Contractor is solely responsible for providing safe



access and any necessary safety equipment required to conduct inspections. The Special Inspector shall not supervise, direct, control, or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the Contractor to comply with Laws and Regulations applicable to the performance of the Work.

- C. Special Inspections shall not relieve the Contractor's obligation to perform and complete work in accordance with the Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- D. The Contractor shall provide advance notice of work to be conducted that will require Special Inspections. If the Special Inspector is delayed in inspecting the work due to inadequate notice or completion of the work, the Contractor shall reimburse the Owner for the cost of additional subsequent Special Inspections.
- E. The Contractor shall promptly correct any discrepancies noted by the Special Inspectors. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. Where EOR approval is required, the Contractor shall report the discrepancy to the EOR in accordance with provisions of the General Conditions. The EOR will authorize any changes to the Contract Documents required for the correction in accordance with provisions of the General Conditions. Copies of all correspondence related to the correction shall be submitted concurrently to the Special Inspections Agency.

### **3.06 BUILDING OFFICIAL OR AUTHORITY RESPONSIBILITIES**

- A. The Building Official will approve qualifications of the Special Inspections Agency, all Special Inspectors, and any Approved Fabricators. The Building Official will approve all forms submitted by the Contractor, any Approved Fabricators, the EOR, the RDPIRC, the Special Inspections Agency, and the Special Inspectors. The Building Official and the Special Inspections Agency shall agree to the frequency of Interim Reports and the submittal deadline for the Final Report.

### **3.07 RDPIRC RESPONSIBILITIES**

- A. The RDPIRC shall complete the Statement of Special Inspections and the Schedule of Special Inspections, unless previously completed by the EOR. The Statement of Special Inspections form included in this Section shall be used unless the Building Official has a preferred form for the Statement of Special Inspections, in which case the Building Official's form may be used and shall be completed by the RDPIRC.
- B. The RDPIRC shall review and coordinate certain aspects of the project, as determined by the Building Official, for compatibility with the design of the building, structure or

building system, including, but not limited to, submittal documents prepared by others, deferred submittal documents and phased submittal documents.

### **3.08 OWNER RESPONSIBILITIES**

- A. The Owner will retain a Special Inspections Agency to perform Special Inspections during construction. The Special Inspections Agency will retain the RDPIRC.

### **3.09 MINIMUM INSPECTION REQUIREMENTS**

- A. Detailed requirements for Special Inspections are shown in the Statement of Special Inspections and the Schedule of Special Inspections, which references the IBC, applicable code standards, and any State or local amendments. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Additional requirements for specific materials listed in other Sections of these Specifications shall also be satisfied. The frequency of inspections shall be continuous or periodic as indicated in the Schedule of Special Inspections and in accordance with applicable building codes.

### **3.10 REPORTS**

- A. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Special Inspections Agency shall submit all required reports to the Building Official, EOR, and RDPIRC as agreed upon with the Building Official. Reports shall indicate the inspections and testing performed and whether work inspected was or was not completed in conformance to Contract Documents and any corrective measures taken. Where EOR approval is required for corrections, the Agency shall maintain copies of all related correspondence and submit with all required reports.

### **3.11 SPECIAL INSPECTIONS FORMS**

- A. This Section includes forms which may be used to meet requirements for written documentation during the performance of Special Inspections in accordance with the IBC. These forms may be replaced with forms meeting IBC requirements provided by the Building Official if available.

**2. SCHEDULE OF SPECIAL INSPECTIONS—CONCRETE CONSTRUCTION (IBC 2021)**  
 (Table 2 is applicable to cast-in-place concrete and precast concrete. See Table 4 for additional inspections for precast concrete.)

Inspection Task	Frequency		Applicable to project		Reference Standard <sup>e</sup>	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Inspect reinforcement, including prestressing tendons, and verify placement</b>		X			ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	1705.3
<b>2. Reinforcing bar welding:</b>					AWS D1.4, ACI 318: 26.6.4	1705.3
a. Verify weldability of reinforcing bars other than ASTM A706		X				
b. Inspect single-pass fillet welds, maximum 5/16"		X				
c. Inspect all other welds	X					
<b>3. Inspect anchors cast in concrete</b>		X			ACI 318: 17.8.2	1705.3
<b>4. Inspect anchors post-installed in hardened concrete members<sup>f</sup>:</b>	X				ACI 318:17.8.2.4, ACI 318: 17.8.2	1705.3
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads						
b. Mechanical anchors and adhesive anchors not defined in 4. a						
<b>5. Verify use of required design mix</b>		X			ACI 318: Ch 19, 26.4.3, 26.4.4	1705.3, 1904.1, 1904.2
<b>6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete</b>	X				ASTM C172, ASTM C31, ACI 318: 26.5, 26.12	1705.3
<b>7. Inspect concrete and shotcrete placement for proper application techniques</b>	X				ACI 318: 26.5	1705.3
<b>8. Verify maintenance of specified curing temperature and techniques</b>		X			ACI 318: 26.5.3-26.5.5	1705.3

Inspection Task	Frequency		Applicable to project		Reference Standard <sup>e</sup>	IBC Reference
	CONT	PER	Y/N	Agent		
<b>9. Inspect formwork for shape, location, and dimensions of the concrete member being formed</b>		X			ACI 318: 26.11.1.2(b)	1705.3

<sup>e</sup> Where applicable, see IBC Section 1705.13, Special Inspections for seismic resistance.

<sup>f</sup> Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

**3. SCHEDULE OF SPECIAL INSPECTIONS—DEEP FOUNDATION ELEMENTS (IBC 2021)**

Inspection Task	Frequency		Applicable to project		IBC Reference
	CONT	PER	Y/N	Agent	
<b>1. Driven deep foundation elements:</b>					
a. Verify element materials, sizes and lengths comply with the requirements	X				1705.7
b. Determine capacities of test elements and conduct additional load tests, as required	X				
c. Inspect driving operations and maintain complete and accurate records for each element	X				
d. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element	X				
e. Steel elements – See Table 1.1					1705.7, 1705.2
f. Concrete elements and concrete-filled elements – See Table 2					1705.7, 1705.3
g. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge (Engineer)					1705.7
<b>2. Cast-in-place deep foundation elements:</b>					
a. Inspect drilling operations and maintain complete and accurate records for each element	X				1705.8
b. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata	X				

capacity. Record concrete or grout volumes					
c. Concrete elements – See Table 2					1705.8, 1705.3
<b>3. Helical pile foundations. Information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the Engineer. Approved geotechnical report and Contract Documents shall be used to determine compliance.</b>	X				1705.9
<b>4. Whenever there is reasonable doubt as to the structural integrity of a deep foundation element, an engineering assessment shall be required, which shall include tests for defects performed in accordance with ASTM D4945, ASTM D5882, ASTM D6760 or ASTM D7949 or other approved method.</b>					1705.10

**4. SCHEDULE OF SPECIAL INSPECTIONS—PRECAST CONCRETE CONSTRUCTION (IBC 2021) (See Table 2 for other inspections applicable to precast concrete and cast-in-place concrete. Table 4 only lists additional inspections required for precast concrete in addition to inspections included in Table 2)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>9</sup>
	CONT	PER	Y/N	Agent		
<b>1. Inspect prestressed concrete for:</b>	X				ACI 318: 26.10	1705.3
a. Application of prestressing forces						
b. Grouting of bonded prestressing tendons						
<b>2. Inspect erection of precast concrete members</b>		X			ACI 318: 26.9	1705.3
<b>3. For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deformability elements (MDE or HDE) in structures assigned to SDC C, D, E, or F, inspect such connections and reinforcement in the field for:</b>					ACI 318: 26.13.1.3  ACI 550.5	1705.3
a. Installation of the embedded parts	X					
b. Completion of the continuity of reinforcement across joints	X					
c. Completion of connections in the field	X					

<b>4. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5</b>		X			ACI 318: 26.13.1.3	1705.3
<b>5. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.</b>		X			ACI 318: 26.11.2	1705.3
<sup>g</sup> Where applicable, see IBC Section 1705.13, Special Inspections for seismic resistance						



**5. SCHEDULE OF SPECIAL INSPECTIONS—MASONRY CONSTRUCTION – LEVEL 2 QUALITY ASSURANCE (IBC 2021)**

Minimum Verification	Applicable to project		Reference Standard		IBC Reference
	Y/N	Agent	TMS 402	TMS 602	
Prior to construction, verification of compliance of submittals				Art. 1.5	1705.4
Prior to construction, verification of $f_m$ , except where specifically exempted by the Code				Art. 1.4B	
During construction, verification of slump flow and Visual Stability Index (VSI) when self-consolidating grout is delivered to the project site				Art. 1.5, 1.6.3	

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402	TMS 602	
<b>1. As masonry construction begins, verify that the following comply:</b>							1705.4
a. Proportions of site-prepared mortar		X				Art. 2.1, 2.6A, 2.6C	
b. Grade, type and size of reinforcement, connectors, and anchor bolts		X				Art. 3.4, 3.6A	
c. Sample panel construction		X				Art. 1.6D	
<b>2. Prior to grouting, verify that the following comply:</b>							
a. Grout space		X				Art. 3.2D, 3.2F	
b. Placement of reinforcement, connectors, and anchor bolts		X			Sec. 6.1, 6.3.1, 6.3.6, 6.3.7	Art. 3.2E, 3.4	

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402	TMS 602	
c. Proportions of site-prepared grout		X				Art. 2.6B, 2.4 G.1.b	
<b>3. Verify compliance of the following during construction:</b>							1705.4
a. Materials and procedures with the approved submittals		X				Art. 1.5	1705.4
b. Placement of masonry units and mortar joint construction		X				Art. 3.3B	
c. Size and location of structural members		X				Art. 3.3F	
d. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction		X			Sec. 1.2.1(e), 6.2.1, 6.3.1		
e. Welding of reinforcement	X				Sec. 6.1.6.1.2		
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F)		X				Art. 1.8C, 1.8D	

<b>Minimum Special Inspection</b>							
<b>Inspection Task</b>	<b>Frequency</b>		<b>Applicable to project</b>		<b>Reference Standard</b>		<b>IBC Reference</b>
	<b>CONT</b>	<b>PER</b>	<b>Y/N</b>	<b>Agent</b>	<b>TMS 402</b>	<b>TMS 602</b>	
g. Placement of grout complies	X					Art. 3.5, 3.6C	
<b>4. Observe preparation of grout specimens, mortar specimens, and/or prisms</b>		X				Art. 1.4B.2.a.3, 1.4B.2.b.3, 1.4B.2.c.3, 1.4B.3, 1.4B.4	1705.4

**6. SCHEDULE OF SPECIAL INSPECTIONS—PLUMBING, MECHANICAL AND ELECTRICAL COMPONENTS (IBC 2021)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Observe anchorage of electrical equipment for emergency and standby power systems in structures assigned to SDC C, D, E or F		X				1705.13.6
2. Observe anchorage of other electrical equipment in structures assigned to SDC E or F		X				1705.13.6
3. Observe installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to SDC C, D, E or F		X				1705.13.6
4. Observe installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to SDC C, D, E or F		X				1705.13.6
5. Observe installation and anchorage of vibration isolation systems in structures assigned to SDC C, D, E or F where the approved construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint		X				1705.13.6
6. Observe installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic sprinkler systems are installed in structures assigned to SDC C, D, E or F to verify one of the following:		X				1705.13.6
a. Minimum clearances have been provided as required by Section 13.2.3 ASCE 7.						
b. A nominal clearance of not less than 3 inches has been provided between automatic protection sprinkler system drops and sprigs						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
and: structural members not used collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems' piping.						
c. Where flexible sprinkler hose fittings are used, special inspection of minimum clearances is not required.						1705.13.6
7. Observe anchorage of steel storage racks that are 8 feet or greater in height in structures assigned to SDC D, E or F						1705.13.7
a. Materials used, to verify compliance with one or more of the material test reports in accordance with the approved construction documents		X				
b. Fabricated storage rack elements		X				
c. Storage rack anchorage installation		X				
d. Completed storage rack system, to indicate compliance with the approved construction documents		X				
8. Observe seismic isolation systems in seismically isolated structures assigned to SDC B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices		X				1705.13.8

**7. SCHEDULE OF SPECIAL INSPECTIONS—ARCHITECTURAL COMPONENTS (IBC 2021)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<p><b>1. Observe erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to SDC D, E or F.</b></p> <p><b>Exceptions:</b></p>		X				1705.13.5
a. Exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer 30 feet or less in height above grade or walking surface						
b. Exterior cladding and interior and exterior veneer weighing 5 psf or less						
c. Interior nonbearing walls weighing 15 psf or less						
<p><b>2. Observe anchorage of access floors in structures assigned to SDC D, E or F.</b></p>		X				1705.13.5.1
<p><b>3. Sprayed fire-resistant materials:</b></p>		X				1705.15
<p>a. Special inspection shall be based on the fire-resistance design as designated in the approved construction documents and shall be performed during construction, with an additional visual inspection after rough installation of electrical, automatic sprinkler, mechanical and plumbing systems, and suspension systems for ceilings, and before concealment, where applicable. Required sample size shall not exceed 110% of that specified by referenced standards. Special</p>						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
inspections and tests shall comply with requirements of 1705.15.1 through 1705.15.6 and shall include the following:  1) Condition of substrates  2) Thickness of application  3) Density in pounds per cubic foot  4) Bond strength adhesion/cohesion  5) Condition of finished application						
<b>4. Mastic and intumescent fire-resistant coatings:</b>		X				
a. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents and shall be performed during construction. Additional visual inspection shall be performed after the rough installation and, where applicable, prior to the concealment of electrical, automatic sprinkler, mechanical and plumbing systems.						1705.16
<b>5. Exterior Insulation and finish systems (EIFS):</b>		X				
a. Special inspections are required for all EIFS applications. Exceptions: 1) EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior						1705.17

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
2) EIFS applications installed over masonry or concrete walls						
b. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a sheathing substrate						
<b>6. Smoke control:</b>		X				
a. Test scope shall be as follows:						
1) During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location						
2) Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification						1705.19
b. Approved agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.						



Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>7. Fire-resistant penetrations and joints:</b>		X				
a. In buildings assigned to Risk Category III or IV, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire containment systems that are tested and listed in accordance with IBC Section 714.4.1.2, 714.5.1.2, 715.3.1 and 715.4 shall be in accordance with Section 1705.18.1 or 1705.18.2						1705.18

**SCHEDULE OF SPECIAL INSPECTIONS (IBC 2018 VERSION)**

**1.1 SCHEDULE OF SPECIAL INSPECTIONS—STEEL CONSTRUCTION (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Inspection Tasks Prior to Welding:</b>						
a. Welder qualification records and continuity records					AISC 360 Section N.5.4	1705.2.1
1) Quality Assurance provided by inspector		O				
2) Quality Control provided by fabricator, erector, or contractor	P					
b. WPS available	P					
c. Manufacturer certifications for welding consumables available	P					
d. Material identification (type/grade)		O				
e. Welder identification system <sup>a</sup>		O				
f. Fit-up of groove welds (including joint geometry)		O				
1) Joint preparations						
2) Dimensions (alignment, root opening, root face, bevel)						
3) Cleanliness (condition of steel surfaces)						
4) Tacking (tack weld quality and location)						
5) Backing type and fit (if applicable)						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
g. Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) - Quality Assurance provided by inspector 1) Joint preparations  2) Dimensions (alignment, root opening, root face, bevel) 3) Cleanliness (condition of steel surfaces) 4) Tacking (tack weld quality and location)		O			AISC 360 Section N.5.4	1705.2.1
h. Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) - Quality Control provided by fabricator, erector, or contractor 1) Joint preparations  2) Dimensions (alignment, root opening, root face, bevel) 3) Cleanliness (condition of steel surfaces) 4) Tacking (tack weld quality and location)	P				AISC 360 Section N.5.4	1705.2.1
i. Configuration and finish of access holes		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
j. Fit-up of fillet welds		O				
1) Dimensions (alignment, gaps at root)						
2) Cleanliness (condition of steel surfaces)						
3) Tacking (tack weld quality and location)						
k. Check welding equipment		O				
<sup>a</sup> Fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.						
<b>2. Inspection Tasks During Welding:</b>					AISC 360 Section N.5.4	1705.2.1
a. Control and handling of welding consumables		O				
1) Packaging						
2) Exposure control						
b. No welding over cracked tack welds		O				
c. Environmental conditions		O				
1) Wind speed within limits						
2) Precipitation and temperature						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
d. WPS followed		O				
1) Settings on welding equipment						
2) Travel speed						
3) Selected welding materials						
4) Shielding gas type/flow rate						
5) Preheat applied						
6) Interpass temperature maintained (min/max)						
7) Proper position (F, V, H, OH)						
e. Welding techniques		O				
1) Interpass and final cleaning						
2) Each pass within profile limitations						
3) Each pass meets quality requirements						
f. Placement and installation of steel headed stud anchors	P					
<b>3. Inspection Tasks After Welding:</b>						
a. Welds cleaned		O			AISC 360 Section N.5.4	1705.2.1
b. Size, length, and location of welds	P					
c. Welds meet visual acceptance criteria	P					
1) Crack prohibition						
2) Weld/base-metal fusion						
3) Crater cross section						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
4) Weld profiles						
5) Weld size						
6) Undercut						
7) Porosity						
d. Arc strikes	P					
e. k-area <sup>b</sup>	P					
f. Weld access holes in rolled heavy shapes and built-up heavy shapes <sup>c</sup>	P					

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
g. Backing removed and weld tabs removed (if required)	P					
h. Repair activities	P					
i. Document acceptance or rejection of welded joint or member	P					
j. No prohibited welds have been added without the approval of the EOR		O				
<p><sup>b</sup> When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 in. of the weld.</p> <p><sup>c</sup> After rolled heavy shapes (see AISC 360 Section A3.1c) and built-up heavy shapes (see AISC 360 Section A3.1d) are welded, visually inspect the weld access hole for cracks.</p>						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>4. Inspection Tasks Prior to Bolting:</b>						
a. Manufacturer's certifications available for fastener materials					AISC 360 Section N.5.6	1705.2.1
1) Quality Assurance provided by inspector	O					
2) Quality Control provided by fabricator, erector, or contractor		P				
b. Fasteners marked in accordance with ASTM requirements		O				
c. Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)		O				
d. Correct bolting procedure selected for joint detail		O				
e. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements		O				
f. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used						
1) Quality Assurance provided by inspector		O				
2) Quality Control provided by fabricator, erector, or contractor	P					
g. Protected storage provided for bolts, nuts,		O				



Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference	
	CONT	PER	Y/N	Agent			
washers, and other fastener components							
<b>5. Inspection Tasks During Bolting:</b>						AISC 360 Section N.5.6	1705.2.1
a. Fastener assemblies placed in all holes and washers and nuts are positioned as required		O					
b. Joint brought to the snug-tight condition prior to the pre-tensioning operation		O					
c. Fastener component not turned by the wrench prevented from rotating		O					
d. Fasteners are pre-tensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges		O					
<b>6. Inspection Tasks After Bolting:</b>						AISC 360 Section N.5.6	1705.2.1
a. Document acceptance or rejection of bolted connections	P						
<b>7. Steel elements of composite construction prior to concrete placement:</b>						AISC 360 Section N.6	1705.2.1
a. Placement and installation of steel deck	P						
b. Placement and installation of steel headed stud anchors	P						
c. Document acceptance or rejection of steel elements	P						
<p><b>Structural Steel Definitions:</b>                      Observe (O) – the inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.                      Perform (P) – these tasks shall be performed for each welded joint or member.</p>							

**1.2 STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Inspection or Execution Tasks Prior to Deck Placement:</b>						
a. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness	P				SDI QA/QC	1705.2.2
b. Document acceptance or rejection of deck and deck accessories	P					
<b>2. Inspection or Execution Tasks After Deck Placement:</b>						
a. Verify compliance of deck and all deck accessories installation with construction documents	P				SDI QA/QC	1705.2.2
b. Verify deck materials are represented by the mill certifications that comply with the construction documents	P					
c. Document acceptance or rejection of installation of deck and deck accessories	P					
<b>3. Inspection or Execution Tasks Prior to Welding:</b>						
a. Welding procedure specifications (WPS) available		O			SDI QA/QC	1705.2.2
b. Manufacturer certifications for welding consumables		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
available						
c. Material identification (type/grade)		O				
d. Check welding equipment		O				
<b>4. Inspection or Execution Tasks During Welding:</b>						
a. Use of qualified welders		O				
b. Control and handling of welding consumables.		O				
c. Environmental conditions (wind speed, moisture, temperature)		O			SDI QA/QC	1705.2.2
d. WPS followed		O				
<b>5. Inspection or Execution Tasks After Welding:</b>						
a. Verify size and location of welds, including support, sidelap, and perimeter welds	P					
b. Welds meet visual acceptance criteria.	P				SDI QA/QC	1705.2.2
c. Verify repair activities.	P					

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
d. Document acceptance or rejection of welds	P					
<b>6. Inspection or Execution Tasks Prior to Mechanical Fastening:</b>						
a. Manufacturer installation instructions available for mechanical fasteners		O			SDI QA/QC	1705.2.2
b. Proper tools available for fastener installation		O				
c. Proper storage for mechanical fasteners		O				
<b>7. Inspection or Execution Tasks During Mechanical Fastening:</b>						
a. Fasteners are positioned as required		O			SDI QA/QC	1705.2.2
b. Fasteners are installed in accordance with manufacturer's instructions		O				
<b>8. Inspection or Execution Tasks After Mechanical Fastening:</b>						
a. Check spacing, type, and installation of support fasteners	P				SDI QA/QC	1705.2.2
b. Check spacing, type, and installation of sidelap fasteners	P					
c. Check spacing, type, and installation of perimeter fasteners	P					
d. Verify repair activities.	P					
e. Document acceptance or rejection of mechanical	P					

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
fasteners						
<b>9. Inspection of welding:</b>						
a. Cold-formed steel deck					SDI QA/QC	1705.2.2
1) Complete and partial joint penetration groove welds; multi-pass fillet welds; single-pass fillet welds > 5/16"; plug and slot welds	X					
2) Single-pass fillet welds < 5/16"		X				
3) Floor and roof deck welds		X				
b. Reinforcing steel					AWS D1.4	1705.3.1
1) Verification of weldability of reinforcing steel other than ASTM A706		X				
2) Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement	X					
3) Shear reinforcement	X					
4) Other reinforcing steel		X				
Structural Steel Definitions: Observe (O) – the inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
Perform (P) – these tasks shall be performed for each welded joint or member.						

**1.3 SCHEDULE OF SPECIAL INSPECTIONS—OPEN-WEB STEEL JOISTS AND JOIST GIRDERS (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>d</sup>
	CONT	PER	Y/N	Agent		
<b>1. Installation of open-web steel joists and joist girders:</b>						1705.2.3
a. End connections – welding or bolted		X			SJI specifications listed in IBC Section 2207.1	
b. Bridging – horizontal or diagonal						
1) Standard bridging		X			SJI specifications listed in IBC Section 2207.1	
2) Bridging that differs from the SJI specifications listed in Section 2207.1		X				
<sup>d</sup> Where applicable, see also IBC Section 1705.12, Special Inspections for seismic resistance						

**2. SCHEDULE OF SPECIAL INSPECTIONS—CONCRETE CONSTRUCTION (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Inspect reinforcement, including prestressing tendons, and verify placement</b>		X			ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	1705.3, 1908.4
<b>2. Reinforcing bar welding:</b>					AWS D1.4, ACI 318: 26.6.4	1705.3
a. Verify weldability of reinforcing bars other than ASTM A706		X				
b. Inspect single-pass fillet welds, maximum 5/16"		X				
c. Inspect all other welds	X					
<b>3. Inspect anchors cast in concrete</b>		X			ACI 318: 17.8.2	1705.3
<b>4. Inspect anchors post-installed in hardened concrete members <sup>f</sup>:</b>	X	X			ACI 318:17.8.2.4, ACI 318: 17.8.2	1705.3
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads						
b. Mechanical anchors and adhesive anchors not defined in 4. a						
<b>5. Verify use of required design mix</b>		X			ACI 318: Ch 19, 26.4.3, 26.4.4	1705.3, 1904.1, 1904.2, 1908.2, 1908.3
<b>6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete</b>	X				ASTM C172, ASTM C31, ACI 318: 26.5, 26.12	1705.3, 1908.10
<b>7. Inspect concrete and shotcrete placement for proper application techniques</b>	X				ACI 318: 26.5	1705.3, 1908.6, 1908.7, 1908.8
<b>8. Verify maintenance of specified curing temperature and techniques</b>		X			ACI 318: 26.5.3-26.5.5	1705.3, 1908.9



Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>9. Inspect formwork for shape, location, and dimensions of the concrete member being formed</b>		X			ACI 318: 26.11.1.2(b)	1705.3

<sup>e</sup> Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance.

<sup>f</sup> Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

**3. SCHEDULE OF SPECIAL INSPECTIONS—DEEP FOUNDATION ELEMENTS (IBC 2018)**

Inspection Task	Frequency		Applicable to project		IBC Reference
	CONT	PER	Y/N	Agent	
<b>1. Driven deep foundation elements:</b>					
a. Verify element materials, sizes and lengths comply with the requirements	X				1705.7
b. Determine capacities of test elements and conduct additional load tests, as required	X				
c. Inspect driving operations and maintain complete and accurate records for each element	X				
d. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element	X				
e. Steel elements					1705.7, 1705.2
f. Concrete elements and concrete-filled elements					1705.7, 1705.3
g. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge (Engineer)					1705.7
<b>2. Cast-in-place deep foundation elements:</b>					
a. Inspect drilling operations and maintain complete and accurate records for each element	X				1705.8
b. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata	X				

capacity. Record concrete or grout volumes					
c. Concrete elements					1705.8, 1705.3
<b>3. Helical pier foundations. Information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the Engineer. Approved geotechnical report and Contract Documents shall be used to determine compliance.</b>	X				1705.9

**4. SCHEDULE OF SPECIAL INSPECTIONS—PRECAST CONCRETE CONSTRUCTION (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>9</sup>
	CONT	PER	Y/N	Agent		
<b>1. Inspect prestressed concrete for:</b>	X				ACI 318: 26.10	1705.3
a. Application of prestressing forces						
b. Grouting of bonded prestressing tendons						
<b>2. Inspect erection of precast concrete members</b>		X			ACI 318: 26.9	1705.3
<b>3. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.</b>		X			ACI 318: 26.11.2	1705.3
<sup>9</sup> Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance						

**5. SCHEDULE OF SPECIAL INSPECTIONS—MASONRY CONSTRUCTION – LEVEL 2 QUALITY ASSURANCE (IBC 2018)**

Minimum Verification	Applicable to project		Reference Standard		IBC Reference
	Y/N	Agent	TMS 402	TMS 602	
Prior to construction, verification of compliance of submittals				Art. 1.5	1705.4
Prior to construction, verification of $f_m$ , except where specifically exempted by the Code				Art. 1.4B	
During construction, verification of slump flow and Visual Stability Index (VSI) when self-consolidating grout is delivered to the project site				Art. 1.5, 1.6.3	

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402	TMS 602	
<b>1. As masonry construction begins, verify that the following comply:</b>							1705.4
a. Proportions of site-prepared mortar		X				Art. 2.1, 2.6A, 2.6C	
b. Grade, type and size of reinforcement, connectors, and anchor bolts		X				Art. 3.4, 3.6A	
c. Sample panel construction		X				Art. 1.6C	
<b>2. Prior to grouting, verify that the following comply:</b>							
a. Grout space		X				Art. 3.2D, 3.2F	
b. Placement of reinforcement, connectors, and anchor bolts		X			Sec. 6.1, 6.3.1, 6.3.6, 6.3.7	Art. 3.2E, 3.4	

<b>Minimum Special Inspection</b>							
<b>Inspection Task</b>	<b>Frequency</b>		<b>Applicable to project</b>		<b>Reference Standard</b>		<b>IBC Reference</b>
	<b>CONT</b>	<b>PER</b>	<b>Y/N</b>	<b>Agent</b>	<b>TMS 402</b>	<b>TMS 602</b>	
c. Proportions of site-prepared grout		X				Art. 2.6B, 2.4 G.1.b	
<b>3. Verify compliance of the following during construction:</b>							1705.4
a. Materials and procedures with the approved submittals		X				Art. 1.5	1705.4
b. Placement of masonry units and mortar joint construction		X				Art. 3.3B	
c. Size and location of structural members		X				Art. 3.3F	
d. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction		X			Sec. 1.2.1(e), 6.2.1, 6.3.1		
e. Welding of reinforcement	X				Sec. 6.1.6.1.2		
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F)		X				Art. 1.8C, 1.8D	

<b>Minimum Special Inspection</b>							
<b>Inspection Task</b>	<b>Frequency</b>		<b>Applicable to project</b>		<b>Reference Standard</b>		<b>IBC Reference</b>
	<b>CONT</b>	<b>PER</b>	<b>Y/N</b>	<b>Agent</b>	<b>TMS 402</b>	<b>TMS 602</b>	
g. Placement of grout complies	X					Art. 3.5, 3.6C	
<b>4. Observe preparation of grout specimens, mortar specimens, and/or prisms</b>		X				Art. 1.4B.2.a.3, 1.4B.2.b.3, 1.4B.2.c.3, 1.4B.3, 1.4B.4	1705.4

**6. SCHEDULE OF SPECIAL INSPECTIONS—MECHANICAL AND ELECTRICAL COMPONENTS (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Observe anchorage of electrical equipment for emergency and standby power systems in structures assigned to SDC C, D, E or F		X				1705.12.6
2. Observe anchorage of other electrical equipment in structures assigned to SDC E or F		X				1705.12.6
3. Observe installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to SDC C, D, E or F		X				1705.12.6
4. Observe installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to SDC C, D, E or F		X				1705.12.6
5. Observe installation and anchorage of vibration isolation systems in structures assigned to SDC C, D, E or F where the approved construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint		X				1705.12.6
6. Observe installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed in structures assigned to SDC C, D, E or F to verify one of the following:		X				1705.12.6
a. Minimum clearances have been provided as required by Section 13.2.3 ASCE 7.						
b. A nominal clearance of not less than 3 inches has been provided between fire protection sprinkler system drops and sprigs and:						



Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
structural members not used collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems' piping.						
c. Where flexible sprinkler hose fittings are used, special inspection of minimum clearances is not required.						1705.12.6
7. Observe anchorage of storage racks that are 8 feet or greater in height in structures assigned to SDC D, E or F		X				1705.12.7
8. Observe seismic isolation systems in seismically isolated structures assigned to SDC B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices		X				1705.12.8

**7. SCHEDULE OF SPECIAL INSPECTIONS—ARCHITECTURAL COMPONENTS (IBC 2018)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Observe erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to SDC D, E or F.</b>  <b>Exceptions:</b>		X				1705.12.5
a. Exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer 30 feet or less in height above grade or walking surface						
b. Exterior cladding and interior and exterior veneer weighing 5 psf or less						
c. Interior nonbearing walls weighing 15 psf or less						
<b>2. Observe anchorage of access floors in structures assigned to SDC D, E or F.</b>		X				1705.12.5.1
<b>3. Sprayed fire-resistant materials:</b>		X				1705.14

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
a. Special inspection shall be based on the fire-resistance design as designated in the approved construction documents and shall comply with requirements of 1705.14.1 through 1705.14.6. Special inspections and tests shall include the following: <ol style="list-style-type: none"> <li>1) Condition of substrates</li> <li>2) Thickness of application</li> <li>3) Density in pounds per cubic foot</li> <li>4) Bond strength adhesion/cohesion</li> <li>5) Condition of finished application</li> </ol>						
<b>4. Mastic and intumescent fire-resistant coatings:</b>		X				
a. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents						1705.15
<b>5. Exterior Insulation and finish systems (EIFS):</b>		X				
a. Special inspections are required for all EIFS applications. Exceptions: <ol style="list-style-type: none"> <li>1) EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior</li> <li>2) EIFS applications installed over masonry or concrete walls</li> </ol>						1705.16

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
b. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a sheathing substrate						
<b>6. Smoke control:</b>		X				
a. Test scope shall be as follows:						
1) During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location						
2) Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification						1705.18

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>7. Fire-resistant penetrations and joints:</b>		X				
a. In buildings assigned to Risk Category III or IV, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire barrier systems that are tested and listed in accordance with IBC Section 714.4.1.2, 714.5.1.2, 715.3 and 715.4 shall be in accordance with Section 1705.17.1 or 1705.17.2						1705.17

**1.2 STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Inspection or Execution Tasks Prior to Deck Placement:</b>						
a. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness	P				SDI QA/QC	1705.2.2
b. Document acceptance or rejection of deck and deck accessories	P					
<b>2. Inspection or Execution Tasks After Deck Placement:</b>						
a. Verify compliance of deck and all deck accessories installation with construction documents	P				SDI QA/QC	1705.2.2
b. Verify deck materials are represented by the mill certifications that comply with the construction documents	P					
c. Document acceptance or rejection of installation of deck and deck accessories	P					
<b>3. Inspection or Execution Tasks Prior to Welding:</b>						
a. Welding procedure specifications (WPS) available		O			SDI QA/QC	1705.2.2
b. Manufacturer certifications for welding consumables available		O				
c. Material identification (type/grade)		O				
d. Check welding equipment		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>4. Inspection or Execution Tasks During Welding:</b>					SDI QA/QC	1705.2.2
a. Use of qualified welders		O				
b. Control and handling of welding consumables		O				
c. Environmental conditions (wind speed, moisture, temperature)		O				
d. WPS followed		O			SDI QA/QC	1705.2.2
<b>5. Inspection or Execution Tasks After Welding:</b>						
a. Verify size and location of welds, including support, sidelap, and perimeter welds	P					
b. Welds meet visual acceptance criteria	P					
c. Verify repair activities	P					
d. Document acceptance or rejection of welds	P					
<b>6. Inspection or Execution Tasks Prior to Mechanical Fastening:</b>					SDI QA/QC	1705.2.2
a. Manufacturer installation instructions available for mechanical fasteners		O				
b. Proper tools available for fastener installation		O				
c. Proper storage for mechanical fasteners		O				
<b>7. Inspection or Execution Tasks During Mechanical Fastening:</b>					SDI QA/QC	1705.2.2

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
a. Fasteners are positioned as required		O				
b. Fasteners are installed in accordance with manufacturer's instructions		O				
<b>8. Inspection or Execution Tasks After Mechanical Fastening:</b>						
a. Check spacing, type, and installation of support fasteners	P				SDI QA/QC	1705.2.2
b. Check spacing, type, and installation of sidelap fasteners	P					
c. Check spacing, type, and installation of perimeter fasteners	P				SDI QA/QC	1705.2.2
d. Verify repair activities	P					
e. Document acceptance or rejection of mechanical fasteners	P					
<b>9. Inspection of welding:</b>						
a. Cold-formed steel deck						
1) Complete and partial joint penetration groove welds; multi-pass fillet welds; single-pass fillet welds > 5/16"; plug and slot welds	X				SDI QA/QC	1705.2.2
2) Single-pass fillet welds < 5/16"		X				
3) Floor and roof deck welds		X				
b. Reinforcing steel						
1) Verification of weldability of reinforcing steel other than ASTM A706		X			AWS D1.4	1705.3.1
2) Reinforcing steel resisting flexural and axial forces in	X					



Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement						
3) Shear reinforcement	X					
4) Other reinforcing steel		X				
<p><b>Structural Steel Definitions:</b>                      Observe (O) – the inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.                      Perform (P) – these tasks shall be performed for each welded joint or member.</p>						

**1.3 SCHEDULE OF SPECIAL INSPECTIONS—OPEN-WEB STEEL JOISTS AND JOIST GIRDERS (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>c</sup>
	CONT	PER	Y/N	Agent		
<b>1. Installation of open-web steel joists and joist girders:</b>						1705.2.3
a. End connections – welding or bolted		X			SJI specifications listed in IBC Section 2207.1	
b. Bridging – horizontal or diagonal						
1) Standard bridging		X			SJI specifications listed in IBC Section 2207.1	
2) Bridging that differs from the SJI specifications listed in IBC Section 2207.1		X				
<sup>c</sup> Where applicable, see also Section IBC 1705.12, Special Inspections for seismic resistance						

**2. SCHEDULE OF SPECIAL INSPECTIONS—CONCRETE CONSTRUCTION (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>d</sup>
	CONT	PER	Y/N	Agent		
<b>1. Inspect reinforcement, including prestressing tendons, and verify placement</b>		X			ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	1705.3, 1908.4
<b>2. Reinforcing bar welding:</b>						
a. Verify weldability of reinforcing bars other than ASTM A706		X			AWS D1.4,	1705.3
b. Inspect single-pass fillet welds, maximum 5/16"		X			ACI 318: 26.6.4	
c. Inspect all other welds	X					
<b>3. Inspect anchors cast in concrete</b>		X			ACI 318: 17.8.2	1705.3
<b>4. Inspect anchors post-installed in hardened concrete members<sup>e</sup>:</b>	X	X				1705.3
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads					ACI 318: 17.8.2.4,	
b. Mechanical anchors and adhesive anchors not defined in 4.a.					ACI 318: 17.8.2	
<b>5. Verify use of required design mix</b>		X			ACI 318: Ch 19, 26.4.3, 26.4.4	1705.3, 1904.1, 1904.2, 1908.2, 1908.3
<b>6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete</b>	X				ASTM C172 ASTM C31 ACI 318: 26.4, 26.12	1705.3, 1908.10
<b>7. Inspect concrete and shotcrete placement for proper application techniques</b>	X				ACI 318: 26.5	1705.3, 1908.6, 1908.7, 1908.8

<b>8. Verify maintenance of specified curing temperature and techniques</b>		X			ACI 318: 26.5.3-26.5.5	1705.3, 1908.9
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Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>d</sup>
	CONT	PER	Y/N	Agent		
<b>9. Inspect formwork for shape, location, and dimensions of the concrete member being formed</b>		X			ACI 318: 26.11.1.2(b)	1705.3
<sup>d</sup> Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance. <sup>e</sup> Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.						

**3. SCHEDULE OF SPECIAL INSPECTIONS—DEEP FOUNDATION ELEMENTS (IBC 2015)**

Inspection Task		Frequency		Applicable to project		IBC Reference
		CONT	PER	Y/N	Agent	
<b>1. Driven deep foundation elements:</b>						
a.	Verify element materials, sizes and lengths comply with the requirements	X				1705.7
b.	Determine capacities of test elements and conduct additional load tests, as required	X				
c.	Inspect driving operations and maintain complete and accurate records for each element	X				
d.	Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element	X				
e.	Steel elements					1705.2, 1705.7
f.	Concrete elements and concrete-filled elements					1705.3, 1705.7
g.	For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge (Engineer)					1705.7
<b>2. Cast-in-place deep foundation elements:</b>						
a.	Inspect drilling operations and maintain complete and accurate records for each element	X				1705.8
b.	Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes	X				

c.	Concrete elements					1705.3, 1705.8
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**4. SCHEDULE OF SPECIAL INSPECTIONS—PRECAST CONCRETE CONSTRUCTION (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference <sup>f</sup>
	CONT	PER	Y/N	Agent		
1. Inspect prestressed concrete for:	X				ACI 318: 26.10	1705.3
a. Application of prestressing forces						
b. Grouting of bonded prestressing tendons						
2. Inspect erection of precast concrete members		X			ACI 318: 26.8	1075.3
3. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.		X			ACI 318: 26.11.2	1075.3
<sup>f</sup> Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance						



**5. SCHEDULE OF SPECIAL INSPECTIONS—MASONRY CONSTRUCTION – LEVEL B  
QUALITY ASSURANCE (IBC 2015)**

Minimum Tests	Applicable to project		IBC Reference
	Y/N	Agent	
Verification of slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with Article 1.5.B.1.b.3 for self-consolidating grout			1705.4
Verification of f'm in accordance with Article 1.4B prior to construction, except where exempted by the Code			1705.4

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402 ACI 530 ASCE 5	TMS 602 ACI 530.1 ASCE 6	
<b>1. Verify compliance with approved submittals</b>		X				Art. 1.5	1705.4
<b>2. As masonry construction begins, verify that the following comply:</b>							1705.4
a. Proportions of site-prepared mortar		X				Art. 2.1, 2.6A	
b. Construction of mortar joints		X				Art. 3.3B	
c. Grade and size of prestressing tendons and anchorage		X				Art. 2.4B, 2.4H	
d. Location of reinforcement, connectors, and prestressing tendons and anchorage		X				Art. 3.4, 3.6A	
e. Prestressing technique		X				Art. 3.6B	
<b>3. Prior to grouting, verify that the following comply:</b>							1705.4

<b>Minimum Special Inspection</b>							
<b>Inspection Task</b>	<b>Frequency</b>		<b>Applicable to project</b>		<b>Reference Standard</b>		<b>IBC Reference</b>
	<b>CONT</b>	<b>PER</b>	<b>Y/N</b>	<b>Agent</b>	<b>TMS 402 ACI 530 ASCE 5</b>	<b>TMS 602 ACI 530.1 ASCE 6</b>	
a. Grout space		X				Art. 3.2D, 3.2F	
b. Grade, type, and size of reinforcement and anchor bolts, and prestressing tendons and anchorages		X			Sec. 6.1	Art. 2.4, 3.4	
c. Placement of reinforcement connectors, and prestressing tendons and anchorages		X			Sec. 6.1, 6.2.1, 6.2.6, 6.2.7	Art. 3.2E, 3.4, 3.6A	1705.4
d. Proportions of site-prepared grout and prestressing grout for bonded tendons		X				Art. 2.6B, 2.4 G.1.b	
e. Construction of mortar joints		X				Art. 3.3B	
<b>4. Verify during construction:</b>							
a. Size and location of structural elements		X				Art. 3.3F	1705.4
b. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction		X			Sec. 1.2.1(e), 6.1.4.3, 6.2.1		
c. Welding of reinforcement	X				Sec. 8.1.6.7.2, 9.3.3.4(c), 11.3.3.4(b)		

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402 ACI 530 ASCE 5	TMS 602 ACI 530.1 ASCE 6	
d. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F)		X				Art. 1.8C, 1.8D	
e. Application and measurement of prestressing force	X					Art. 3.6B	
f. Placement of grout and prestressing grout for bonded tendons complies	X					Art. 3.5, 3.6C	
<b>5. Observe preparation of grout specimens, mortar specimens, and/or prisms</b>		X				Art. 1.4B.2.a.3 1.4B.2.b.3 1.4B.2.c.3 1.4B.3, 1.4B.4	1705.4

**6. SCHEDULE OF SPECIAL INSPECTIONS—MECHANICAL AND ELECTRICAL COMPONENTS (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Observe anchorage of electrical equipment for emergency and standby power systems in structures assigned to SDC C, D, E or F		X				1705.12.6
2. Observe anchorage of other electrical equipment in structures assigned to SDC E or F		X				1705.12.6
3. Observe installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to SDC C, D, E or F		X				1705.12.6
4. Observe installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to SDC C, D, E or F		X				1705.12.6
5. Observe installation and anchorage of vibration isolation systems in structures assigned to SDC C, D, E or F where the approved construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint		X				1705.12.6
6. Observe anchorage of storage racks that are 8 feet or greater in height in structures assigned to SDC D, E or F		X				1705.12.7
7. Observe seismic isolation systems in seismically isolated structures assigned to SDC B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices		X				1705.12.8

**7. SCHEDULE OF SPECIAL INSPECTIONS—ARCHITECTURAL COMPONENTS (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>1. Observe erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to SDC D, E or F. Exceptions:</b>		X				1705.12.5
a. Exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer 30 feet or less in height above grade or walking surface						
b. Exterior cladding and interior and exterior veneer weighing 5 psf or less						
c. Interior nonbearing walls weighing 15 psf or less						
<b>2. Observe anchorage of access floors in structures assigned to SDC D, E or F.</b>		X				1705.12.5.1
<b>3. Sprayed fire-resistant materials:</b>		X				1705.14
a. Special inspection shall be based on the fire-resistance design as designated in the approved construction documents and shall comply with requirements of 1705.14.1 through 1705.14.6. Special inspections and tests shall include the following:						
1) Condition of substrates						
2) Thickness of application						
3) Density in pounds per cubic foot						
4) Bond strength adhesion/cohesion						
5) Condition of finished application						
<b>4. Mastic and intumescent fire-resistant coatings:</b>		X			AWCI 12-B	1705.15

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
a. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents						
<b>5. Exterior insulation and finish systems (EIFS):</b>		X				
a. Special inspections are required for all EIFS applications. Exceptions: 1) EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior 2) EIFS applications installed over masonry or concrete walls						1705.16
b. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a sheathing substrate						
<b>6. Smoke control:</b>		X				
a. Test scope shall be as follows: 1) During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location 2) Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification						1705.18

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
<b>7. Fire-resistant penetrations and joints:</b>		X				
a. In buildings assigned to Risk Category III or IV, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire barrier systems that are tested and listed in accordance with Section 714.3.1.2, 714.4.2, 715.3 and 715.4 shall be in accordance with Section 1705.17.1 or 1705.17.2						1705.17

**8. SCHEDULE OF SPECIAL INSPECTIONS—SOILS (IBC 2015)**

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity		X				1705.6
2. Verify excavations are extended to proper depth and have reached proper material		X				
3. Perform classification and testing of compacted fill materials		X				
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill	X					
5. Prior to placement of compacted fill, preserve subgrade and verify that site has been prepared properly		X				

<b>9. Special Inspections Agency Contact Information:</b>	
1.	
2.	
3.	
4.	



**STATEMENT OF SPECIAL INSPECTIONS**

**PROJECT:** \_\_\_\_\_

**LOCATION:** \_\_\_\_\_

**PERMIT APPLICANT:** \_\_\_\_\_

**APPLICANT'S ADDRESS:** \_\_\_\_\_

**ARCHITECT OF RECORD:** \_\_\_\_\_

**STRUCTURAL ENGINEER OF RECORD:** \_\_\_\_\_

**MECHANICAL ENGINEER OF RECORD:** \_\_\_\_\_

**ELECTRICAL ENGINEER OF RECORD:** \_\_\_\_\_

**REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE:** \_\_\_\_\_

This Statement of Special Inspections is submitted in accordance with Section 1704 of the International Building Code. It shall be considered in conjunction with the Schedule of Special Inspections included in this Specification Section 01 45 33. If applicable, it includes *Requirements for Seismic Resistance and/or Requirements for Wind Resistance*.

Are Requirements for Seismic Resistance included in the Statement of Special Inspections?  Yes  No

Are Requirements for Wind Resistance included in the Statement of Special Inspections?  Yes  No

The Special Inspector(s) shall keep detailed records of all inspections, including a copy at the jobsite. All records shall be available upon request by the Engineer or the Building Official. Any discrepancies shall be brought to the immediate attention of the Contractor. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Engineer prior to completion of that phase of work. The Special Inspections Agency shall furnish Interim Reports to the Building Official and to the Engineer at the frequency indicated in the Statement of Special Inspections. A Final Report shall be submitted to the Building Official and the Engineer at the time agreed upon by the Owner and the Building Official.

**Frequency of Interim Report submittals to the Building Official:**

\_\_\_ Weekly \_\_\_ Bi-Weekly \_\_\_ Monthly Other; specify: \_\_\_\_\_

**Frequency of Interim Report submittals to the Engineer:**

\_\_\_ Weekly \_\_\_ Bi-Weekly \_\_\_ Monthly Other; specify: \_\_\_\_\_

Special Inspections do not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

**Statement of Special Inspections Prepared by:**

\_\_\_\_\_  
 Type or print name

\_\_\_\_\_



\_\_\_\_\_  
Signature Date

**Building Official's Acceptance:**

\_\_\_\_\_  
Type or print name

\_\_\_\_\_  
Signature Date

**STATEMENT OF SPECIAL INSPECTIONS**

**REQUIREMENTS FOR SEISMIC RESISTANCE**

See the Schedule of Special Inspections for inspection and testing requirements.

Seismic Design Category: \_\_\_\_\_

Statement of Special Inspection for Seismic Resistance Required (Yes/No): \_\_\_\_\_

**Description of seismic force-resisting system subject to special inspection and testing for seismic resistance:**

**Description of designated seismic systems in accordance with Chapter 13 of ASCE 7 subject to special inspection and testing for seismic resistance. Special inspector shall verify that the label, anchorage and mounting of these systems conforms to the Contract Documents and Approved Submittals:**

**Description of additional seismic systems and components requiring special inspections:**

**Description of additional seismic systems and components requiring testing:**

**Statement of Responsibility:**

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

**STATEMENT OF SPECIAL INSPECTIONS**

**REQUIREMENTS FOR WIND RESISTANCE**

See the Schedule of Special Inspections for inspection and testing requirements.

**Basic Wind Speed (3 second gust): \_\_\_\_\_ m.p.h.**

**Wind Exposure Category: \_\_\_\_\_**

**Statement of Special Inspection for Wind Resistance Required (Yes/No): \_\_\_\_\_**

**Description of main wind force-resisting system subject to special inspection for wind resistance:**

**Description of wind force-resisting components subject to special inspection for wind resistance:**

**Statement of Responsibility:**

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

**INTERIM REPORT OF SPECIAL INSPECTIONS**

<b>City/County of:</b>							
<b>Project Name/Address:</b>				<b>Inspection Type(s) Coverage:</b>			
				<input type="checkbox"/> <b>Continuous</b>		<input type="checkbox"/> <b>Periodic</b>	
<b>Describe Inspections Made, Including Locations:</b>							
<b>Tests Made:</b>							
<b>Total Inspection Time Each Day</b>	<b>Date:</b>						
	<b>Hours:</b>						
<b>List items requiring Special Inspection, and any discrepancies and corrections. If Engineer approval is required for any corrections, note this, and indicate that approval was obtained. Attach copies of all related correspondence.</b>							
<b>Comments:</b>							

To the best of my knowledge, work inspected was in accordance with the Contract Documents and applicable standards except as noted above.

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

Print Full Name: \_\_\_\_\_

I.D.: \_\_\_\_\_

Hazen and Sawyer

Project No.: 70123-000

Phone Number:

**This report is to be submitted to the Building Official and the Engineer. A copy shall be maintained at the jobsite.**

**FINAL REPORT OF SPECIAL INSPECTIONS**

**PROJECT:** \_\_\_\_\_

**LOCATION:** \_\_\_\_\_

**PERMIT APPLICANT:** \_\_\_\_\_

**APPLICANT'S ADDRESS:** \_\_\_\_\_

**ARCHITECT OF RECORD:** \_\_\_\_\_

**STRUCTURAL ENGINEER OF RECORD:** \_\_\_\_\_

**MECHANICAL ENGINEER OF RECORD:** \_\_\_\_\_

**ELECTRICAL ENGINEER OF RECORD:** \_\_\_\_\_

**REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE:** \_\_\_\_\_

To the best of my information, knowledge, and belief, Special Inspections required for this Project in accordance with Section 1704 of the International Building Code and any State or local amendments have been performed, and all work has been completed in accordance with the Contract Documents and all applicable standards, except as indicated.

The Special Inspection program does not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

This Final Report includes information submitted in previous Interim Reports numbered \_\_\_\_\_ to \_\_\_\_\_, as well as any Special Inspections, discrepancies, and corrections occurring since the last Interim Report, dated \_\_\_\_\_.

All items requiring Special Inspection are listed below. All inspections, tests, and similar services that were performed are listed and any discrepancies and corrections are indicated. If Engineer approval was required for any corrections, this is noted, and copies of all related correspondence are attached.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

*(Attach 8 1/2"x11" continuation sheet(s) if required to complete the description of corrections)*

**Prepared By:**

10/21/2024  
Central Weber Sewer Improvement District  
Dewatering Building HVAC Improvements

Special Inspector's Seal

Hazen and Sawyer

Project No.: 70123-000

---

Special Inspection Agency:

---

Type or print name

---

Signature

Date



**CONTRACTOR'S STATEMENT OF RESPONSIBILITY**

Each Contractor responsible for the construction or fabrication of a main-wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections must submit this Statement of Responsibility prior to commencement of work on the system or component.

**Project:** \_\_\_\_\_

**Contractor's Name:** \_\_\_\_\_

**Address:** \_\_\_\_\_

**License No.:** \_\_\_\_\_

**Description of building systems and components included in Statement of Responsibility:**  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Contractor's Acknowledgement of Special Requirements**

*I hereby acknowledge that I have received, read, and understand the Statement of Special Inspections and its requirements.*

\_\_\_\_\_  
Name and Title (type or print)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date



**Attach copy of Building Official's approval of fabricator as an Approved Fabricator.**

**NOTIFICATION OF FAILURE TO CORRECT DISCREPANCY**

<b>City/County of:</b>
<b>Project Name/Address:</b>
<b>List discrepancies, proposed correction, and Contractor response. If Engineer approval is required for any corrections, note this, and indicate whether approval was obtained. Attach copies of all related correspondence.</b>
<b>Comments:</b>

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

Print Full Name: \_\_\_\_\_

I.D.: \_\_\_\_\_

Hazen and Sawyer

Project No.: 70123-000

\_\_\_\_\_  
Phone Number: \_\_\_\_\_

**This report is to be submitted to the Building Official, the Contractor, and the Engineer.**

**END OF SECTION**

**SECTION 01 51 00**  
**TEMPORARY UTILITIES**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Contractor shall provide temporary utilities required for the Project and to complete the Work.
1. Make arrangements with utility service companies for temporary services and obtain required permits and approvals for temporary utilities.
  2. Pay utility service costs, including connection fees, required for the Work as needed.
  3. Continuously maintain adequate utilities for all purposes during the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities through Substantial Completion and removal of temporary field offices and sheds.
  4. Should Owner occupy part of the Project prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by Owner will be shared proportionately between Owner and Contractor as mutually agreed to by the parties.
  5. Maintain, including cleaning, temporary utilities and continuously provide consumables as required.
  6. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and requirements of Project.
  7. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.
- B. Provide the following temporary utilities:
1. Electricity and lighting.
  2. Telephone and communications.
  3. Heating and ventilation to maintain six air changes per hour.
  4. Sanitary facilities.

5. Water service.
6. First-aid facilities.
7. Fire protection.

## **1.02 ADMINSTRATIVE REQUIREMENTS**

### **A. Use of Owner's System:**

1. Existing Utility Systems: Do not use systems in existing buildings or structures for temporary utilities without Owner's written permission and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between Owner and Contractor.
2. Use of Permanent Utility Systems Provided Under the Project:
  - a. Permanent lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
    - 1) Obtain Owner's written permission to use permanent systems.
    - 2) Permanent systems to be used for temporary utilities or temporary facilities shall have achieved Substantial Completion, including complete functionality of all controls.
    - 3) Contractor shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
  - b. Do not use the following permanent facilities:
    - 1) Telephone and communication facilities.
    - 2) Sanitary facilities.
    - 3) Cranes

## **1.03 SYSTEM DESCRIPTION**

### **A. Electricity and lighting:**

1. Contractor shall provide electrical and lighting service for construction field offices, sheds, storage containers, etc. and as required for the Work.
2. General 120/240 V service requirements:



- a. Contractor shall provide 120/240 V, single phase, 3-wire temporary system for small power requirements and general lighting.
  - b. Contractor shall provide main disconnect, overcurrent protection, meter outlet, branch circuit breakers, and wiring for temporary service to the Contractor's field office service connections. Contractor shall provide equipment and appurtenances in accordance with electricity service provider and applicable standards and codes
  - c. Contractor shall register the 120/240 V electrical service meter in the Contractor's name and shall be responsible for electrical charges at no additional cost to the Owner.
  - d. Contractor shall provide electrical service other than 120/240 V, single phase, 3-wire service as required for the Work at the Contractor's own expense.
3. General lighting requirements:
- a. Contractor shall provide a minimum of 10 foot candles for enclosed and partially enclosed structures for performing the Work.
  - b. Contractor shall provide a night lighting circuit for security. Light intensity shall be a minimum of 2 foot candles.
4. Contractor shall energize the electrical system 15-minutes prior to and following regular work day hours at the Site. Required from Monday through Friday, all inclusive.
5. Contractor shall energize the night lighting system at end of typical working day and de-energize at start of typical working day. System shall be continuously energized on Saturdays, Sundays, and holidays.
6. Contractor shall provide an independent grounding cable connected directly to the structure, building, and equipment for erection and fabrication by electrical welders. Grounding by adjacent conduit, piping, etc. shall be prohibited at the Site.
7. Contractor shall coordinate usage of temporary electrical system with Subcontractors, Suppliers, and Owner including the following:
- a. Usage is suitable for 120V, single phase, 60 Hz operation with a maximum operating input of 1,500 volt-amperes.
  - b. One unit connected to a single outlet.
  - c. Restrict usage in case of overloading circuits to correct loading.

- B. Telephone and communications: Contractor shall provide temporary telephone and communications required for its operations at the Site and for summoning emergency medical assistance.
- C. Heating & Ventilation:
1. Contractor shall provide temporary heating and ventilation to maintain a minimum of six (6) air changes per hour (ACH) in the process areas while the existing HVAC system is being replaced.
  2. Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to protect the Work and materials against wetness and temperature damage, to dry out the Work, and to facilitate the Work in structures.
  3. Equipment, fuel, materials, personnel and methods used shall be adequate to maintain critical installation temperatures and ventilation of Work at all times in areas where necessary to perform the Work.
  4. Enclosed structures shall have a minimum temperature of 50°F, unless otherwise specified, where Work is performed.
  5. Contractor shall provide sufficient heat to maintain a minimum temperature of 65°F before and during application of interior finishing, painting, coating, etc.
  6. Contractor shall replace any Work damaged by dampness or insufficient/abnormal heating at no cost to the Owner.
- D. Sanitary facilities:
1. Contractor shall provide suitably-enclosed chemical or self-contained toilets for Contractor's employees and visitors to the Site. Location of temporary toilets shall be acceptable to Owner and screened from public observation.
  2. Facilities shall be maintained and provided in accordance with State or Commonwealth Labor Regulations and local ordinances. Contents shall be removed and disposed in accordance with local and state or commonwealth regulations as required.
  3. Contractor shall be prohibited from committing nuisances within, on, or in the vicinity of the Site.
- E. Water service:
1. Contractor shall provide temporary water service for the Work including for construction purposes, sanitary facilities, fire protection, field office, and cleaning purposes.

2. Contractor shall provide potable water for Contractor's personnel either by portable containers or drinking fountains.
3. Contractor shall provide temporary hose bibs, hoses, and watertight barrels for the distribution of water.
4. Contractor shall provide freeze protection for water service.

F. First-aid facilities:

1. Contractor shall provide temporary first-aid stations at or immediately adjacent to the Site's major work areas. Contractor shall provide temporary first-aid stations inside its temporary field office. Locations of first-aid stations shall be determined by Contractor's safety representative.
2. Contractor shall provide list of emergency telephone numbers at each hardwired telephone at the Site. List shall be in accordance with the list of emergency contact information required in Section 01 31 19 – Project Meetings.

G. Fire protection:

1. Contractor shall comply with NFPA 241, Safeguarding Building Construction, Alteration, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.
2. Contractor shall provide temporary fire exits, fire extinguishers, hoses and safety devices as required by authorities having jurisdiction.
3. Contractor shall notify Engineer, Owner, and fire marshals in the event of fire at the Site including, but not limited to, fuel tanks and similar hazardous utilities and devices. Contractor shall cooperate with Owner of fuel tank and utilities to prevent occurrence of fire or explosion.
4. Contractor shall perform safety precautions and comply with fire marshal's instructions in the event of fire.

## **PART 2 – PRODUCTS**

### **2.01 EQUIPMENT**

- A. Materials and equipment for temporary systems may be new or used but shall be adequate for purposes intended and shall not create unsafe conditions and shall comply with Laws and Regulations.

- B. Provide required materials, equipment, and facilities, including piping, wiring, and controls.
- C. Electrical system requirements: System shall consist of wiring, switches, insulated supports, poles, fixtures, sockets, receptacles, lamps, guards, cutouts and fuses as required for completion of the Work.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Install temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.
- B. Location of Temporary Utilities and Temporary Facilities:
  - 1. Locate temporary systems for proper function and service.
  - 2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.
  - 3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.
- C. Modify and extend temporary systems as required by progress of the Work.

### **3.02 MAINTENANCE**

- A. Maintain temporary systems to provide safe, continuous service as required.
- B. Properly supervise operation of temporary systems:
  - 1. Enforce compliance with Laws and Regulations.
  - 2. Enforce safe practices.
  - 3. Prevent abuse of services.
  - 4. Prevent nuisances and hazards caused by temporary systems and their use.
  - 5. Prevent damage to finishes.
  - 6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

- C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.
- D. Contractor shall replace broken and burned out lamps, blown fuses, and damaged wiring and appurtenances as required to maintain adequate and safe operating conditions.
- E. Contractor shall permit subcontractors and others at a mutually agreed arrangement to use temporary electrical system that meet the following requirements:
  - 1. Equipment are suitable for 120 V, single phase, 60 Hz operation.
  - 2. Operating input does not exceed 1,500 volt-amperes.
  - 3. Single piece of equipment connected to one outlet.
  - 4. Contractor shall restrict use of equipment as required to prevent overloading circuits.

### **3.03 CLOSEOUT ACTIVITES**

- A. Completely remove temporary utilities, facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.
- B. Contractor is responsible for and shall return to original condition those portions of permanent electric system used in completing the Work.
- C. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.
- D. When permanent utilities and systems that were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

**END OF SECTION**

**SECTION 01 55 00  
CONTRACTOR ACCESS AND PARKING**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Contractor shall provide and maintain temporary laydown and employee parking areas and appurtenances required during the Project for use by Contractor, other contractors employed on the Project, Owner's, and emergency vehicles.
2. Laydown and employee parking areas shall be designed and maintained by Contractor and shall be fully passable to vehicles in all weather conditions.
3. Contractor may utilize the area directly north of the Dewatering Building, including the grass area across the access drive, for temporary trailers, equipment storage and staging.

**1.02 ADMINSTRATIVE REQUIREMENTS**

A. Access hours:

1. Access shall be limited to the hours of 7:00 am – 5:00 pm, Monday – Friday. For access beyond these times, Contractor shall coordinate with owner (Clay Marriot 801-731-3011).

B. Use of existing access roads:

1. Contractor will be allowed to use Owner's existing roads and enter the plant through the main gate.
2. Prevent interference with traffic on existing roads and parking areas. At all times, keep access roads and entrances serving the Site clear and available to Owner, Owner's employees, emergency vehicles, and other contractors. Do not use access roads or Site entrances for parking or storage of materials or equipment.
3. Contractor shall indemnify and hold harmless Owner and Engineer from expenses caused by Contractor's operations over existing roads and parking areas.
4. Schedule deliveries to minimize use of driveways and Site entrances.
5. Contractor shall suitably maintain existing access road at Contractor's expense for the duration of the Contract time.

## C. Contractor parking areas:

1. Contractor employee vehicles shall park in area(s) designated by Owner.
2. Contractor shall construct and maintain parking area at the Site.

## D. Site security:

1. Contractor shall safely guard all the Work, the Project, products, equipment, and property from loss, theft, damage, and vandalism until Substantial Completion. Contractor's duty includes safely guarding Owner's property in vicinity of the Work and Project, and other private property in the vicinity of the Project from injury and loss in connection with performance of the Project.
2. Employ watchmen as required to provide required security and prevent unauthorized entry.
3. Costs for security required under this Section shall be paid by Contractor.
4. Make no claim against Owner for damage resulting from trespass.
5. Pay full compensation for, or repair or replace, damage to property of Owner and others arising from failure to furnish adequate security.
6. Provide temporary fencing in accordance with the Contract Documents.
7. Security requirements specified in the Section shall begin as soon as the contractor delivers materials to the Site and/or begins work, and shall continue until the date of Final Completion.
8. Procedures:
  - a. Contractor shall conform to Owner's security procedures and access restrictions at Site throughout entire Project.
  - b. Contractor, including Subcontractors and Suppliers, shall comply with the following:
    - 1) Personnel Identification: All Contractor personnel shall wear at all times on-Site a badge bearing Contractor's name, employee's name and, as applicable, employee number.
    - 2) Parking: Do not park outside of designated Contractor parking area, which is shown on the Drawings. Prepare and maintain parking area as required. Personal vehicles are not allowed outside Contractor parking area.

9. Contractor shall provide and maintain temporary security fencing if existing security fencing or barriers are breached or temporarily removed for the Project at no additional cost to the Owner. Temporary security fencing shall be equal to existing, unless otherwise specified, and provided and maintained in a manner satisfactory to Engineer and Owner.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Contractor shall determine if and where temporary fencing is necessary, unless existing security fencing is damaged, which will be determined by Engineer and Owner.
- B. Install temporary fencing used for site security in accordance with the Contract Documents and fence manufacturer's instructions. Provide temporary fencing for site security so that integrity of site security is maintained throughout the Project.
- C. Maintain temporary fencing. Repair damage to temporary fencing and replace fencing when required to maintain site security.
- D. Remove temporary fencing when permanent site security fencing is in place and fully functional, or when otherwise directed by Owner or Engineer.

**END OF SECTION**



**SECTION 01 61 00  
PRODUCT REQUIREMENTS AND OPTIONS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. Common requirements for products.
  - 2. Contractor’s options for selecting products.
  - 3. Requirements for consideration of “or equal” products.
  - 4. Warranty requirements of products.

**1.02 REFERENCES**

- A. Definitions:
  - 1. “Products” includes materials, equipment, machinery, components, fixtures, systems, and other goods incorporated in the Work. Products do not include machinery and equipment used for preparing, fabricating, conveying, erecting, or installing the Work. Products include Owner-furnished goods incorporated in the Work where use of such goods is specifically required in the Contract Documents.
  - 2. “Special Warranties” includes additions or modifications to standard warranty requirements specified in the Contract Documents.

**1.03 SUBMITTALS**

- A. Warranty Log Book:
  - 1. Submit warranty log book prepared specifically for this Project. Submittal shall include a summary listing of all equipment and material warranties furnished in the Contract, date received, and start/end date of warranty period. Individual warranty documentation shall be provided in the submittal.
  - 2. Submit prior to submittal of final application for payment.
- B. Patent Documentation: Submit licensing arrangement and agreement documentation.

**1.04 REQUIREMENT**

- A. Common Products:

1. Provide products that have not been previously incorporated into another project or facility unless otherwise indicated in the Contract Documents.
  2. Provide products of the same generic kind from a single source.
  3. Provide products complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.
  4. Standard Products: When available, and unless custom or nonstandard options are specified or indicated, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  5. Visual Matching: Where required in the Contract Documents, provide products that match referenced existing construction, approved mock-ups, or approved Sample, as determined by Engineer.
  6. Where the Contract Documents include the phrase “as selected” for product color, finish pattern, option, or similar phrase, provide products selected by Engineer as follows:
    - a. Standard Range: Where the Contract Documents include the phrase “standard range of colors, patterns, textures” or similar phrase, provide color, pattern, density, or texture selected by Engineer from manufacturer’s product line that does not include premium items.
    - b. Full Range: Where the Contract Documents include the phrase “full range of colors, patterns, textures” or similar phrase, Engineer will select color, pattern, density, or texture from manufacturer’s entire product line, including standard and premium items.
- B. Product Compatibility:
1. Similar products by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents.
  2. Provide products compatible with products previously selected or installed on the Project.
- C. Product Options:
1. For products specified only by reference standard or description, without reference to Supplier, provide products meeting that standard, by a Supplier or from a source that complies with the Contract Documents.

2. For products specified by naming one or more products or Suppliers, provide the named products that comply with the Contract Documents, unless an “or equal” or substitute product is approved by Engineer.
3. For products specified by naming one or more products or Suppliers and the term, “or equal”, when Contractor proposes a product or Supplier as an “or equal”, submit to Engineer a request for approval of an “or equal” product or Supplier.
4. For products specified by naming only one product or manufacturer and followed by words indicating that no substitution is allowed, there is no option and no substitution will be allowed.

D. Concerning Patents:

1. Owner shall be provided a guarantee by Contractor and equipment Supplier that equipment and material furnished in accordance with the Contract Documents is not the subject of patent litigation.
2. Patent litigation or controversy shall include, but not limited to, the following:
  - a. Actual furnished equipment and material the is subject or could be subject to patent litigation or is known to infringe on a patent.
  - b. Furnished equipment and material that may result in a process that use of equipment and material in a manner that infringes upon or violates a patent.
3. When patent infringement may occur, Contractor and Supplier shall submit license arrangements among parties, including Contractor, Supplier, and patent owner (controller of patent) at a minimum, which shall permit use of equipment and material as specified in the Contract Documents.
4. Supplier shall indemnify and hold harmless Owner and Engineer against all claims, costs, losses, and damages arising out of or relating to any infringement or patent rights or copyrights incident to the use of equipment and material specified in the Contract Documents and as required in General Conditions and as modified in the Supplemental Conditions.

E. “Or Equal” Products:

1. For proposed products not named in the Contract Documents and considered as an “or equal” as defined in the General Conditions, Contractor shall request in writing Engineer’s approval of the “or equal”. Request for approval of an “or equal” product shall accompany the Shop Drawing or product data submittal for the proposed product and shall include:

- a. Contractor's request that the proposed product be considered as an "or equal" in accordance with the General Conditions, accompanied by Contractor's certifications required in the General Conditions.
- b. Documentation adequate to demonstrate that proposed product does not require revisions to the Contract Documents, that proposed product is consistent with the Contract Documents, and that proposed product will produce results and performance required in the Contract Documents, and that proposed product is compatible with other portions of the Work.
- c. Detailed comparison of significant qualities of proposed product with the products and manufacturers named in the Contract Documents. Significant qualities include attributes such as performance, weight, size, durability, visual effect, performance and specific features and requirements shown or indicated.
- d. Evidence that proposed product manufacturer will furnish warranty equal to or better than specified, if any.
- e. List of similar installations for completed projects with project names and physical addresses of installation along with the names, telephone numbers, email addresses and physical address of design professionals and owners associated with the referenced installation, if requested.
- f. Samples, if requested.
- g. Other information requested by Engineer.

#### **1.05 WARRANTY**

- A. Warranties specified for products shall be in addition to, and run concurrent with, Contractor's general warranty and guarantee and requirements for the required correction period. Disclaimers and limitations in specific product warranties do not limit Contractor's general warranty and guarantee.
  1. Product manufacturer's warranty is preprinted written warranty published by product manufacturer and specifically endorsed by product manufacturer to Owner.
  2. Equipment and material shall be guaranteed to be free from defects in workmanship, design, and/or materials for a period of one (1) year unless otherwise specified in the individual Specification Section for a Special Warranty.
  3. Warranty period shall start on the date of the particular equipment and material is substantially complete, which includes requirements specified in Section 01 75 00 – Checkout and Startup Procedures for start-up certification and specified elsewhere in the Contract Documents.

4. Warranty requirements may be added to or modified in the individual Specification Sections. Special warranty is written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by product manufacturer's warranty or to provide increased rights to Owner.
  5. Special warranty information, if any, will be located in the Specification Section for that product.
- B. Requirements for Special Warranties: Provide written special warranty document that contains appropriate terms and identification, ready for execution by product manufacturer and Owner. Submit draft warranty with submittals required for product.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed by product manufacturer and other parties as appropriate.
  2. Specified Form: When specified forms are included in the Contract Documents, prepare written document, properly executed by product manufacturer and Owner, using appropriate form.
  3. Refer to Specifications for content and requirements for submitting special warranties.
- C. Submit product manufacturer's warranties and special warranties as submittals in accordance with Schedule of Submittals accepted by Engineer.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 65 00**  
**PRODUCT DELIVERY REQUIREMENTS**

**PART 1 – GENERAL****1.01 SUMMARY**

## A. Section includes:

1. General requirements for preparing for shipping, delivering, and handling materials and equipment.
2. Contractor shall make all arrangements for transporting, delivering, and handling of materials and equipment required for prosecution and completion of the Work.

**1.02 SUBMITTALS**

- A. Refer to individual Specification Sections for submittal requirements relative to delivery and handling materials and equipment.

**1.03 SHIPMENT REQUIREMENTS**

- A. When practical, factory-assemble materials and equipment. Match mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable, protective coating.
- B. Package materials and equipment to facilitate handling, and protect materials and equipment from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate the associated purchase order number, bill of lading number, contents by name, Owner's contract name and number, Contractor name, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.
- C. Protect materials and equipment from exposure to the elements and keep thoroughly dry and dust-free at all times. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Lubricate bearings and other items requiring lubrication in accordance with manufacturer's instructions.
- D. Advance Notice of Shipments:
  1. Keep Engineer informed of delivery of all materials and equipment to be incorporated in the Work.
- E. Do not ship materials and equipment until:

1. Related Shop Drawings, Samples, and other submittals have been approved or accepted (as applicable) by Engineer, including, but not necessarily limited to, Submittals associated with the materials and equipment being delivered.
2. Manufacturer's instructions for handling, storing, and installing the associated materials and equipment have been submitted to and accepted by Engineer in accordance with the Specifications.
3. Results of source quality control testing (factory testing), when required by the Contract Documents for the associated materials or equipment, have been reviewed and accepted by Engineer.
4. Facilities required for handling materials and equipment in accordance with manufacturer's instructions are in place and available.
5. Required storage facilities have been provided.

#### **1.04 DELIVERY REQUIREMENTS**

##### **A. Scheduling and Timing of Deliveries:**

1. Arrange deliveries of materials and equipment in accordance with the accepted Progress Schedule and in ample time to facilitate inspection prior to installation.
  - a. Equipment and material shall not be delivered to the Site prior to 90 days in advance of scheduled installation.
  - b. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are improperly stored.
2. Schedule deliveries to minimize space required for and duration of storage of materials and equipment at the Site or delivery location, as applicable.
3. Coordinate deliveries to avoid conflicting with the Work and conditions at Site, and to accommodate the following:
  - a. Work of other contractors and Owner.
  - b. Owner's operations and maintenance.
  - c. Storage space limitations.
  - d. Availability of equipment and personnel for handling materials and equipment.
  - e. Owner's use of premises.

4. Deliver materials and equipment to the Site during regular working hours.
5. Deliver materials and equipment to avoid delaying the Work and the Project, including work of other contractors, as applicable. Deliver anchor system materials, including anchor bolts to be embedded in concrete or masonry, in ample time to avoid delaying the Work.

B. Deliveries:

1. Shipments shall be delivered with Contractor's name, Subcontractor's name (if applicable), Site name, Project name, and contract designation clearly marked.
2. Site may be listed as the "ship to" or "delivery" address; but Owner shall not be listed as recipient of shipment unless otherwise directed in writing by Engineer.
3. Provide Contractor's telephone number to shipper; do not provide Owner's telephone number.
4. Arrange for deliveries while Contractor's personnel are at the Site. Contractor shall receive and coordinate shipments upon delivery. Shipments delivered to the Site when Contractor is not present will be refused by Owner, and Contractor shall be responsible for the associated delays and additional costs, if incurred.

C. Containers and Marking:

1. Have materials and equipment delivered in manufacturer's original, unopened, labeled containers.
2. Clearly mark partial deliveries of component parts of materials and equipment to identify materials and equipment, to allow easy accumulation of parts, and to facilitate assembly.

D. Inspection of Deliveries:

1. Immediately upon delivery, Contractor shall inspect shipment to verify that:
  - a. Materials and equipment comply with the Contract Documents and approved or accepted (as applicable) submittals.
  - b. Quantities are correct.
  - c. Materials and equipment are undamaged.
  - d. Containers and packages are intact and labels are legible.
  - e. Materials and equipment are properly protected.



2. Promptly remove damaged materials and equipment from the Site and expedite delivery of new, undamaged materials and equipment, and remedy incomplete or lost materials and equipment to furnish materials and equipment in accordance with the Contract Documents, to avoid delaying progress of the Work.
3. Advise Engineer in writing when damaged, incomplete, or defective materials and equipment are delivered, and advise Engineer of the associated impact on the Progress Schedule.

#### **1.05 HANDLING REQUIREMENTS**

- A. Provide equipment and personnel necessary to handle materials and equipment, including those furnished by Owner, by methods that prevent soiling or damaging materials and equipment and packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring, and otherwise damaging materials and equipment and surrounding surfaces.
- C. Handle materials and equipment by methods that prevent bending and overstressing.
- D. Lift heavy components only at designated lifting points.
- E. Handle materials and equipment in safe manner and as recommended by the manufacturer to prevent damage. Do not drop, roll, or skid materials and equipment off delivery vehicles or at other times during handling. Hand-carry or use suitable handling equipment.

#### **PART 2 – PRODUCTS (NOT USED)**

#### **PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 66 00**  
**PRODUCT STORAGE AND PROTECTION REQUIREMENTS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. General requirements of storing and protecting equipment and materials.

**1.02 STORAGE**

- A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents.
- B. Contractor shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment. Construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to Owner, other contractors, public travel, and owners, tenants, and occupants of adjoining property. Arrange storage in manner to allow easy access for inspection.
- C. Areas available at the Site for storing materials and equipment are shown or indicated in the Contract Documents, or as approved by Engineer.
- D. Store materials and equipment to become Owner's property to facilitate their inspection and ensure preservation of quality and fitness of the Work, including proper protection against damage by freezing, moisture, and high ambient temperatures. Store in indoor, climate-controlled storage areas all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to Owner.
- E. Contractor shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
- F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer, directed by Engineer or otherwise specified in the Contract Documents.

- G. Do not store materials or equipment in structures being constructed unless approved by Engineer in writing.
- H. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.
- I. Contractor shall not store unnecessary equipment and materials at the Site.
- J. Contractor shall prevent structures from being loaded with a weight that endanger its security and/or safety of persons.
- K. Stored equipment and materials shall not be placed within 10 feet of fire hydrants.
- L. Gutters, drainage channels and inlets shall be kept unobstructed at all times.

### **1.03 PROTECTION**

- A. Contractor shall provide temporary storage containers/facilities, if required, to protect equipment and materials at the Site.
- B. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage, in accordance with Section 01 65 00 – Product Delivery Requirements.
- C. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
- D. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of Engineer.

### **1.04 SPECIFIC STORAGE REQUIREMENTS**

- A. Uncovered:
  - 1. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
    - a. Piping, except polyvinyl chloride (PVC) or chlorinated PVC (CPVC) pipe.
- B. Covered:
  - 1. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:

- a. Grout and mortar materials.
  - b. Rough lumber.
  - c. PVC and CPVC pipe.
2. Tie down covers with rope, and slope covering to prevent accumulation of water.
- C. Fully Protected:
1. All materials and equipment not named as uncovered or covered in this Section, shall be stored on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully closed walls on all sides. Covering with plastic sheeting or similar material in space without floor, roof, and walls is not acceptable. Comply with the following:
    - a. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
    - b. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures.
    - c. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
    - d. Maintain humidity at levels recommended by manufacturers of electrical and electronic equipment.
    - e. Energize space heaters for electrical equipment and material.
- D. Maintenance of Storage: On scheduled basis, periodically inspect stored materials and equipment to ensure that:
1. Condition and status of storage facilities is adequate to provide required storage conditions.
  2. Required environmental conditions are maintained on continuing basis.
  3. Materials and equipment exposed to elements are not adversely affected.

## 1.05 RECORDS

- A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 73 00**  
**DEMOLITION AND EXECUTION OF WORK**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section includes:

1. Contractor shall provide labor, materials, tools, equipment, and incidentals shown, specified, and required for execution of the Work as specified in this Section, including the following:
  - a. Construction Electronic Documentation
  - b. Demolition
  - c. Cutting and Coring
  - d. Patching
  - e. Installation
2. Requirements for demolition, removal and disposal of existing buildings, structures, pavement, curbs, and sidewalks and electrical, plumbing, heating and ventilation equipment and materials as indicated in the Contract Documents for demolition.
3. General requirements for installation of equipment and material. Additional installation requirements are included in the individual Specification Sections.
4. General requirements for connections to existing facilities. Requirements for tie-ins and shutdowns necessary to complete the Work are included in Section 01 14 00 – Coordination with Owner’s Operations.
  - a. To extent possible, materials, equipment, systems, piping, and appurtenances that will be placed into service upon completion of connection to existing facilities shall be checked, successfully tested, and in condition for operation prior to making connections to existing facilities, if valves, gates, or similar watertight and gastight isolation devices are not provided at the connection point.

5. Requirements for cutting and coring, and rough and finish patching of holes and openings in existing construction. Provide cutting, coring, fitting, and patching, including attendant excavation and fill, required to complete the Work, and to:
  - a. Remove and replace defective Work.
  - b. Remove samples of installed Work as specified or required for testing.
  - c. Remove construction required to perform required alterations or additions to existing work.
  - d. Connect to completed Work not performed in proper sequence.
  - e. Remove or relocate existing utilities and pipes that obstruct the Work in locations where connections must be made.
  - f. Make connections or alterations to existing or new facilities.

B. Related Sections:

1. Section 01 14 00 – Coordination with Owner’s Operations
2. Section 01 51 00 – Temporary Utilities
3. Section 01 61 00 – Product Requirements and Options
4. Section 01 66 00 – Product Storage and Protection Requirements
5. Section 01 74 00 – Cleaning and Waste Management

## 1.02 REFERENCES

A. Definitions:

1. “Manufacturer’s installation instructions” includes manufacturer’s written instructions; drawings; illustrative, wiring, and schematic diagrams; diagrams identifying external connections; and other such information pertaining to installation of equipment and materials. Installation instructions are printed instructions, including those attached to the equipment and materials, all inclusive.
2. “Salvage” items are equipment and materials shown on the Contract Documents for selective removal by the Contractor to furnish to the Owner. Contractor shall be responsible for removal, handling, and depositing of equipment and material to location designated by Owner.

B. Reference Standards:

1. 29 CFR 1910, OSHA.
2. ANSI A10, Construction and Demolition Operations

### **1.03 ADMINISTRATIVE REQUIREMENTS**

#### **A. Coordination:**

1. Review installation procedures under other Sections and coordinate Work that must be performed with or before the Work specified in this Section.
2. Notify other contractors in advance of Work for connections to existing facilities to prevent delay of the Work.
3. Remove and dispose of equipment and materials indicated for demolition on the Contract Documents, unless indicated as salvage items for the Owner. Contractor shall obtain ownership of removed equipment and materials following Engineer and Owner approval. Disposal of equipment and materials shall be in accordance with the Contract Documents

#### **B. Sequencing:**

1. Contractor shall remove and demolish equipment and materials in sequence specified in Section 01 14 00 – Coordination with Owner's Operations and following approval by Engineer and Owner.
2. Contractor shall replace equipment and materials removed without proper authorization from Engineer, which are necessary for the operation of the existing facilities. Re-installation of equipment and materials shall be to the satisfaction of the Engineer at no cost to the Owner

#### **C. Title to Equipment and Materials:**

1. Equipment and materials indicated for demolition and removal in the Contract Documents, and not designated as Owner's salvaged items, shall become the Contractor's property following removal from the Site. Contractor shall be responsible for legally disposing of the equipment and material.
2. Contractor shall have no right or title to any of the equipment, materials, or other items to be removed until the elements have been removed from the Site.
3. Contractor shall not sell or assign or attempt to sell or assign any interest in the equipment, materials, or other items until removal from Site.
4. Contractor shall have no claim against the Owner because of the absence of equipment, fixtures, and materials.



**D. Salvage Equipment and Materials:**

1. Contract Documents indicate equipment and materials that shall be retained by Owner. Owner has the right to request any demolished equipment and materials be retained at their discretion.
2. Contractor shall move salvaged equipment and materials to storage areas located at the Site as instructed by Owner.
3. Architectural equipment and materials may be salvaged for incorporation into the Work when approved by Engineer.

**1.04 SUBMITTALS****A. Action/Informational Submittals:**

1. Construction electronic documentation as specified in this Section.
2. Demolition Plan: Submit detailed description of methods, equipment, and sequence for demolition Work, including means of ensuring stability of structures during demolition activities.
3. Cutting and Patching Request:
  - a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:
    - 1) Design function or intent of Project.
    - 2) Work of Owner or other contractors.
    - 3) Structural value or integrity of an element of the Project.
    - 4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
    - 5) Efficiency, operational life, maintenance, or safety of operational elements.
    - 6) Visual qualities of sight-exposed elements.
  - b. Request shall include:
    - 1) Identification of Project and contract name and number.
    - 2) Description of affected Work of Contractor and work of others (if any).

- 3) Necessity for cutting.
  - 4) Effect on work of Owner, other contractors (if any), and on structural or weatherproof integrity of Project.
  - 5) Description of proposed Work, including scope of cutting and patching; trades who will be executing the Work; products proposed to be used; extent of refinishing; schedule of operations; alternatives to cutting and patching, if any.
  - 6) Designation of entity responsible for cost of cutting and patching, when applicable.
  - 7) Written permission of other contractors (if any) whose work will be impacted.
4. Recommendation Regarding Cutting and Patching:
- a. Should conditions of work, or schedule, indicate a change of materials or methods, submit written recommendation to Engineer including:
    - 1) Conditions indicating change.
    - 2) Recommendations for alternative materials or methods.
    - 3) Items required with substitution request, in accordance with the substitution request requirements of the Contract Documents and Section 01 61 00 – Product Requirements and Options.
  5. Product Data: Submit manufacturer's product data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces, as well as means of protecting exposed reinforcement or other metal embedments.
  6. Informational Submittal: Submit written indication designating the day and time that the construction associated with cutting and patching will be uncovered, to allow observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.
  7. Comply with submittal requirements of individual Specification Sections for patching materials.

#### **1.05 SITE CONDITIONS**

- A. Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.

- B. Existing Site conditions shall be maintained to the greatest extent possible by the Owner to the time of Notice to Proceed.
- C. Contractor shall perform investigations, explorations, and probes as necessary at the Site prior to initiating demolition Work to ascertain any required protective measures before proceeding with demolition and removal. Contractor shall give particular attention to shoring and bracing requirements to prevent damage to the Work and existing structures.
- D. Contractor shall verify measurements, dimensions and other conditions of each existing structure, system, equipment, and material indicated in the Contract Documents for new Work prior to ordering equipment and materials.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. General:
  - 1. Provide materials and products in accordance with the individual Specification Sections and the Contract Documents.
  - 2. Provide materials and products that visually match existing adjacent surfaces to fullest extent possible for exposed surfaces.
  - 3. If not indicated in the Contract Documents, provide materials and products that are identical to existing materials and products affected by the Work.
  - 4. If identical materials and products are unavailable, provide materials and products that shall equal or exceed performance requirements of existing materials and products.
- B. Protective Coating Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
  - 1. All concrete surfaces exposed due to cutting or core drilling shall be coated with an epoxy resin coating such as Sikagard 62 by Sika Corporation, Durakote 240 by Tamms Industries or approved equal.
  - 2. Reinforcement or other metal embedment exposed by concrete cutting or core drilling shall be burned back a minimum of ½ inch below surface and resulting void shall be filled with an epoxy resin binder.

## **PART 3 – EXECUTION**

### **3.01 CONSTRUCTION ELECTRONIC DOCUMENTATION**

#### **A. Pre-Construction Documentation**

1. Contractor shall take photographic and video documentation of the Site where Work is being performed. Engineer and Owner reserve the right to be present during documentation.
2. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site prior to commence Work.
3. Contractor shall submit pre-construction documentation to Engineer and Owner for review. Contractor, Engineer, and Owner shall visit Site to field verify electronic documentation prior to commencing the Work. Site visit verification shall establish existing conditions prior to commencing Work.

#### **B. Construction Progress Documentation**

1. Contractor shall document Work progress at locations and construction as directed by Engineer, at a minimum.
2. Contractor shall provide electronic documentation prior to and following any shutdown, switchover, demolition, de-commissioning, cutting, patching, repair, etc. Engineer and Owner reserve the right to be present during documentation.
3. Contractor shall document following exposure of buried utilities, piping, valve, appurtenances, and other underground elements.
4. Engineer reserves the right to provide construction progress documentation to confirm Contractor electronic documentation.

#### **C. Post-Construction Documentation**

1. Contractor shall take photographic and video documentation of the Site where Work has been completed and prior to Substantial Completion or partial utilization by Owner. Engineer and Owner reserve the right to be present during documentation.
2. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site following completion of the Work.

#### **D. Submittal Requirements:**

1. Documentation shall be time stamped for verification, including date and time.

2. Documentation shall be organized in a logical manner, such as by structure, building, physical site location, etc. for easy of comparison.
3. Photographic documentation shall be high resolution electronic versions.
4. Documentation shall be submitted to Engineer for review and approval prior to commence Work and at completion of the Work.

### **3.02 DEMOLITION**

#### **A. General:**

1. Demolition Work shall comply with the applicable provisions and recommendation of ANSI A10, Construction and Demolition Operations standards, all governing codes, and as specified in this Section.
2. Contractor shall furnish competent and experienced personnel for the various type of demolition and removal Work. Demolition and removal Work shall be performed with regard to the safety of Owner employees, individuals at the Site, and the public.
3. Contractor shall confirm absence of embedded utilities prior to cutting, coring, or demolishing existing concrete and facilities. Verification shall be performed by portable x-ray, ground penetrating radar, or other non-invasive methods.
  - a. Contractor shall notify Engineer and Owner if embedded utilities are located during the investigation. Contractor shall clearly mark and document location of embedded utilities prior to performing the Work.
  - b. Contractor shall be responsible for repair and damages caused by exploration, investigation, and performance of the Work at no additional cost to Owner.
4. Contractor shall remove temporary work, such as enclosures, signs, guards, etc. when such temporary Work is no longer required or when directed at the completion of the Work.
5. Contractor shall perform patching, restoration and Work in accordance with individual Specification Sections and details shown on Contract drawings.
6. Contractor shall be responsible for damage caused by demolition Work to existing structures, equipment and materials indicated for reuse or to remain at no additional cost to Owner.
7. Contractor shall maintain a clean working environment during the demolition Work in accordance with Section 01 74 00 – Cleaning and Waste Management.

8. Contractor shall proceed with the demolition work in a sequence designed to maintain the plant in operation in accordance with Section 01 14 00 – Coordination with Owner's Operations.
9. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris. Select fill or structural fill shall be used where specifically required on Contract Drawings.
10. All debris resulting from the demolition and removal work shall be disposed of by the Contractor at a properly permitted facility as part of the work of this Contract. All regulations covering material handling and disposal shall be followed. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of off-site by the Contractor at his expense. Burning of any debris resulting from the demolition will not be permitted at the site.

B. Protection during Demolition:

1. Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, personnel engaged in demolition Work, and adjacent construction.
2. Contractor shall provide and maintain weather protection at exterior openings to fully protect the interior premises against damage from the elements until such openings are closed by the Work.
3. Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and Work is being done, connections made, materials handled, or equipment moved.
4. Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster, and similar debris. Unaltered portions of the existing buildings affected by the operations in the Contract Documents shall be protected by dust proof partitions and other adequate means.
5. Contractor shall provide adequate fire protection in accordance with Section 01 51 00 – Temporary Utilities and authorities having jurisdiction.
6. Contractor shall perform the demolition Work with minimum traffic interference. Contractor shall not close or obstruct walkways, passageways, or stairways. Contractor shall not store or place materials in passageways, stairs, or other means of egress.

7. Contractor shall minimize disturbances to exterior walls and roofs to small sections that are readily repaired and patched to maintain watertight conditions in existing structures and buildings.

C. Performance of Demolition:

1. Equipment, piping, valves, and appurtenances:
  - a. Contractor shall drain equipment, piping, valves, and appurtenances prior to demolition Work. Contractor shall be responsible for collection, transport, and disposal of drained contents at no additional cost to the Owner.
  - b. Contractor shall provide line stops, plugs, blind flanges, etc. for equipment, piping, valves, and appurtenance required to remain in service during the Project. Contractor shall provide temporary or permanent supports in accordance with the Contract Documents.
  - c. Supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise noted in the Contract Documents.
  - d. Concrete bases, anchor bolts and other supports shall be removed to approximately 1 inch below the surrounding finished area and the recesses shall be filled with epoxy resin binder.
  - e. Wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, in accordance with the Contract Documents and as directed by the Engineer.
  - f. Wall sleeves, wall pipes, and wall castings shall be plugged or blanked off in accordance with the Contract Documents and as directed by the Engineer.
  - g. Openings in concrete shall be closed in accordance with the Contract Documents and as directed by the Engineer.
2. Electrical components and equipment:
  - a. Contractor shall de-energize panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar electrical equipment prior to removal.
  - b. Contractor shall relocate or isolate electrical equipment and materials that serve equipment, piping, valves, and appurtenance that are to remain in service during the Project. Relocation or isolation Work shall be sequenced and scheduled in accordance with Section 01 14 00 – Coordination with Owner's Operations.

3. Reused and relocated equipment:
  - a. Contractor shall receive approval from Engineer prior to removal and relocation of equipment and material. Equipment and materials removed by Contractor prior to Engineer's approval that is required for Owner's operation of the facility shall be reinstalled at no cost to the Owner.
  - b. Prior to removal and relocation Work, equipment and materials indicated for reuse and relocation shall be operated by Owner with Contractor and Engineer present to witness existing functionality and operation.
  - c. Contractor shall provide personnel responsible for reinstallation of equipment and material for the removal Work.
  - d. Contractor shall be responsible and provide storage and protection of equipment and materials in accordance with Section 01 66 00 – Product Storage and Protection Requirements until relocation and reinstallation Work is performed.
  - e. Contractor shall provide replacement equipment and material that is damaged during the removal Work at new cost to the Owner. Contractor shall be responsible to provide same type, model, electrical components, etc. equipment and material as approved by Engineer and Owner.
4. Structural removal:
  - a. Contractor shall provide and install temporary shoring, struts, and bracing required for the demolition Work to ensure stability during entire demolition process.
  - b. Contractor shall cut and remove structural material at the interface of demolition Work and the existing structural element. Cutting and removal shall occur in small sections, including masonry units, to prevent instability of structural elements.
  - c. Contractor shall patch, repair, and refinish adjacent surfaces that remain following demolition Work.
    - 1) Adjacent surfaces shall be repaired and refinished to the condition prior to the demolition Work and in accordance with the Contract Documents.
    - 2) Adjacent surfaces shall be cleaned of dirt, grease, loose paint, etc., prior to refinishing.



- d. Contractor shall limit cutting of existing roof areas designated to remain to the limits required for the proper installation of the Work.
  - 1) Cut and remove insulation, joists, flashing, membranes, shingles, and metals, etc. in accordance with the Contract Documents and as directed by the Engineer for installation of the Work.
  - 2) Provide temporary weather tight protection as required until new roofing and flashings are installed.
5. Architectural repairs and removal Work, not specifically shown on the Drawings, may include, but not limited to, the following:
  - a. Brickwork: Re-pointing; removing and replacing broken, cracked, disintegrating and missing materials.
  - b. Windows: Removing cracked or disintegrating sealant material; replacing missing or broken glass; re-caulking and sealing frames; glazing sealants.
  - c. Re-finishing: Removing rust, sealing, or peeling paint from surfaces by scraping, sanding or wire brushing; priming and repainting surfaces.
  - d. Roofing: Patching and repairing membrane or built-up roofing; metal flashing repair; correcting roof pitch to eliminate ponding; cleaning and/or replacing roof drains.
  - e. Masonry: Cutting and installing new expansion and control joints.
  - f. Parapets: Removing and construction of new walls and copings; clean and patching of copings; replacing copings where broken.
  - g. Concrete surfaces: Patching, cleaning, sealing and resurfacing floors, walls, lintels, sills, and trim. Replace lintels where broken. Patching or replacing broken, spalled, cracked and disintegrating concrete encased steel columns and piers.
  - h. Openings: Cutting and modifying as required for new Work. Provide new lintels, doors, and frames.
  - i. Doors: Patching and refinishing doors and frames.
  - j. Ceilings: Patching, refinishing, and replacing.
  - k. Guards, handrails, and appurtenances: Cleaning and repainting steel materials. Replacing steel material with new aluminum material.

- I. Demolished Exterior Openings: Remove window sash, frame, sill, stool and trim at exterior doors indicated for enclosure and sealing. Provide brick and/or masonry block for closure and sealing.

D. Maintenance during Demolition:

1. Contractor shall maintain the buildings, structures, and public properties free from accumulations of waste, debris and rubbish, generated by the demolition Work.
2. Contractor shall provide cleaning and waste management of demolition equipment and materials in accordance with Section 01 74 00 – Cleaning and Waste Management.

### 3.03 CUTTING AND CORING

A. General:

1. Contractor shall notify Engineer in writing and receiving Engineer's approval prior to cutting load bearing walls (concrete or masonry) and structural concrete floors.
2. Perform cutting and coring to limit extent of patching required.
3. Structural Elements: Do not cut or core structural elements in manner that would change structural element's load-carrying capacity or load deflection ratio.
4. Operating Elements: Do not cut or core operating elements in manner that would reduce capacity to perform as intended. Do not cut or core operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.
5. Replace, patch, and repair materials and surfaces cut or damaged during cutting and coring Work. Contractor shall use methods that do not void required or existing warranties.
6. Provide temporary or permanent bypass provisions prior to cutting existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated in accordance with the Contract Documents.
7. Inspection: Examine and prepare surfaces prior to commencing Work. Contractor shall report unsatisfactory or questionable conditions to Engineer in writing. Contractor shall not proceed with the Work until unsatisfactory conditions are corrected.
8. Preparation:

- a. Provide temporary support required to maintain structural integrity, to protect adjacent Work from damage, and to support the element(s) to be cut or cored.
  - b. Protection of Existing Construction During Cutting and Coring:
    - 1) Protect existing structures, equipment, and materials during cutting and coring to prevent damage.
    - 2) Provide protection from adverse weather conditions that will be exposed during cutting and coring Work.
    - 3) Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
9. Restoration:
- a. Clean equipment, materials, piping systems, valves, conduit and appurtenances that were damaged due to the Work prior to applying paint or other finishing materials.
  - b. Restore damaged pipe coverings, including insulation, to original condition.
- B. Cutting:
1. General:
    - a. Cut existing structures and appurtenances that provide surfaces for installation or repair of the Work. Cut existing construction using methods to minimize damage and disturbance to retained and adjoining construction elements.
    - b. Cutting equipment used shall be hand or small power tools suitable for sawing or grinding. Avoid using hammering or chopping equipment for cutting Work.
    - c. Cut holes and slots as small as possible and to size required for incorporation of the Work and in accordance with the Contract Documents.
    - d. Cut or drill from exposed or finished side to concealed side to avoid marring finished surfaces.
    - e. Provide adequate bracing of area to be cut prior to cutting.
    - f. Provide equipment and material to remove cut spoils.

- g. Provide temporary protection for cut openings where and when Work is not being performed.
2. Concrete and Masonry:
- a. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
  - b. Provide control for slurry generated during sawing on both sides of element being cut.
  - c. After cutting concrete and before installing new Work on or through the opening, coat exposed concrete and steel with protective coating material specified in this Section. Apply protective coating in accordance with manufacturer's instructions.

C. Coring:

- 1. Core-drill holes through concrete and masonry walls, slabs, or arches, in accordance with the Contract Documents, unless written authorization is furnished by Engineer.
- 2. Protection: Protect existing structures, equipment, materials, utilities, and adjacent areas from water and other damage by core-drilling Work.
- 3. Coring:
  - a. Perform coring with non-impact rotary tool using diamond core-drills.
  - b. Size holes for pipe, conduit, sleeves, equipment, or mechanical seals, as required, to be installed through the penetration and in accordance with the Contract Documents.
  - c. After core-drilling and before installing equipment and material through the penetration, coat exposed concrete and steel with protective coating material specified in this Section. Apply protective coating in accordance with manufacturer's instructions.
- 4. Cleaning: Vacuum or otherwise remove slurry and tailings from the work area following core-drilling.

### 3.04 PATCHING

A. General:

1. Construction shall be patched by filling, repairing, refinishing, closing-up, and similar methods at completion of the Work.
2. Provide equipment and materials in accordance with the Contract Documents for patching Work. Comply with manufacturer's installation instructions.
3. Provide airtight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces when patching the Work. Provide durable patching seams that minimize visual appearance.
4. Patched areas shall be tested to demonstrate integrity of installation as directed by the Engineer. Contractor shall provide testing equipment, material, and services for patch testing.

B. Restoration:

1. Restore exposed finishes of patched areas to minimize evidence of patching and refinishing.
2. Contractor shall extend refinishing and restoration into adjoining areas to blend patched areas with existing adjacent areas.
  - a. Refinish to nearest intersection for continuous surfaces.
  - b. Refinish the entire assembly and system for equipment and materials.
  - c. Repair and rehang existing ceilings to provide an even-plane surface of uniform appearance.
  - d. Apply plaster and finishes to match adjacent interior walls and partition areas for openings sealed with brick and/or masonry block.

### 3.05 INSTALLATION

- A. Install equipment and materials in accordance with the Contract Documents, approved Shop Drawings, and manufacturer's installation instructions. When manufacturer's installation instructions conflict with the Contract Documents, obtain interpretation or clarification from Engineer before proceeding.
- B. Preparation of surfaces shall be performed prior to installation of equipment and material.
  1. New floor finishes: Repair and patch with concrete, asphalt latex type emulsion and underlayment as required for existing surfaces or new flooring surfaces.

2. Ceramic tile flooring or bases installed over concrete floors: Grind away cove, if present, for installation of new Work.
- C. Concrete surfaces shall achieve compression strength in accordance with the Contract Documents prior to installation of equipment and materials.
1. Anchor bolts and templates shall be provided by Contractor and as specified in the individual Specification Sections.
  2. Concrete foundations shall be treated with sealer to prevent oil from seeping into concrete as specified in the individual Specification Sections.
- D. Maintain the work area in a broom-clean condition while installing materials and equipment.
- E. Contractor shall be responsible for equipment for hoisting, lifting, moving, rigging, etc. for installation of equipment and materials.
1. Contractor shall be responsible for design of temporary installation system used for the installation Work, unless otherwise indicated in the Contract Documents.
  2. Contractor shall be responsible for damage to existing structure, equipment, and material caused prior, during, and following installation of the Work with the Contractor furnished temporary installation system at no cost to Owner. Repairs shall be in accordance with the Contract Documents, shall return to condition prior to installation Work, and as directed by the Engineer.
  3. Owner's hoists, monorails, bridge cranes, rigging, etc. shall not be used by the Contractor unless written authorization is provided by Owner.
- F. Alteration or repair of new equipment and materials shall not be permitted without written authorization from Engineer.
- G. Field welding or burning of new equipment and materials shall not be permitted unless indicated in the Contract Documents or without written authorization from Engineer.
- H. Contractors shall install temporary shoring and bracing where necessary during installation of the Work where required:
1. System shall be provided in accordance with the Contract Documents and code requirements.
  2. Temporary system shall consist of adjustable sound timbers or rolled shapes easily removable following installation of the Work.

3. Contractor shall be responsible for damage to existing structures and new Work during installation, utilization, and removal of the temporary system at new additional cost to the Owner.
  
- I. Manufacturer's Installation Services: Provide competent, qualified manufacturer's representatives of equipment and material for services specified in the individual Specification Sections, including, but not limited to:
  1. Supervising installation
  2. Checking the completed installation
  3. Adjusting and testing of equipment and materials

**END OF SECTION**

**SECTION 01 73 23**  
**ANCHORAGE AND BRACING OF NONSTRUCTURAL COMPONENTS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish all equipment, labor, materials, and services required to design and provide anchorage and bracing for all nonstructural components in accordance with the Contract Documents and Building Code requirements, including the seismic design requirements of Chapter 13 in ASCE 7.
- B. This Section covers requirements for only the anchorage and bracing of nonstructural components. Design requirements for nonstructural components (other than their anchorage and bracing) are covered in the Section for that component.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01 45 33 – Special Inspections
- B. Section 05 10 00 – Metal Materials
- C. Section 05 05 23 – Metal Fastening
- D. Further requirements for anchorage and bracing are included in other Sections of the Specifications. See Section for the specific nonstructural component in question.

**1.03 DEFINITIONS**

- A. Nonstructural components: All architectural, mechanical, electrical, or plumbing elements or systems and their supports or attachments provided under this contract which are permanently attached to new or existing structures.
  - 1. Architectural nonstructural components include, but are not limited to, interior nonstructural walls and partitions, exterior wall panels and glazing elements, glass curtain walls, skylights, cabinets, suspended ceilings, fascia, and cladding.
  - 2. Mechanical nonstructural components include, but are not limited to, HVAC units, fans, water and wastewater treatment process equipment, instrumentation cabinets, piping and ductwork.



3. Electrical nonstructural components include, but are not limited to, conduit systems, cable tray systems, boxes, transformers, panelboards, switchboards, switchgear, busway, individual motor controllers, motor control centers, variable frequency drives, automatic transfer switches, and lighting systems.
  4. Plumbing nonstructural components include, but are not limited to, sprinkler systems and associated piping, and sump pumps.
- B. Attachment: Elements including anchor bolts, welded connections, and mechanical fasteners which secure nonstructural components or supports to the structure.
- C. Essential Components: Nonstructural components considered necessary to public safety for which the component importance factor  $I_p$  is required by chapter 13 in ASCE 7 to be taken as 1.5, including:
1. Life safety systems which must function following an earthquake, including but not limited to, sprinklers for fire protection, emergency lighting, egress corridors and stairways, and smoke purge systems.
  2. Components which contain, convey or support toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Building Code.
  3. Components which are within or attached to an Occupancy or Risk Category IV structure as defined in ASCE 7 Chapter 1 and are needed for continued operation of the facility or failure could impair the continued operation of the facility.
  4. Components which contain, convey, or support hazardous substances and are attached to a structure or portion thereof classified by the Building Code as a hazardous occupancy.
  5. Process systems and elements designated below:
    - a. Process elements essential for filter press operation.
- D. Nonbuilding Structures: All self-supporting structures which are supported by an independent foundation or by other structures which include, but are not limited to, storage tanks, silos, exhaust stacks, storage racks, and towers.
- E. Delegated Design: Design of a structure or structural element(s) which has been deferred by the contract documents to be performed during the project construction stage, by a registered design professional retained by the Contractor and with the design submitted as a shop drawing to the Engineer.

## 1.04 REQUIREMENTS

- A. Anchorage and bracing of nonstructural components shall be designed and installed to resist the controlling load combination of gravity loads, operational forces (including static and dynamic), wind forces, seismic forces and any other applicable forces required in accordance with the governing Building Code.
- B. Anchorage and bracing of nonstructural components shall comply with seismic design requirements of ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt. The following nonstructural components are exempt from requirements specific to seismic anchorage and bracing: (See paragraph 1.07.F.3 herein for Seismic Design Category)
1. Storage cabinets no more than 6 feet tall, furniture, and movable equipment, regardless of Seismic Design Category.
  2. All architectural, mechanical, electrical, and plumbing nonstructural components in Seismic Design Category A.
  3. All mechanical, electrical, and plumbing nonstructural components in Seismic Design Category B.
  4. Architectural nonstructural components in Seismic Design Category B, other than parapets, provided that  $I_p = 1.0$ .
  5. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category C provided that either:
    - a.  $I_p = 1.0$ , and the component is positively attached to the structure, or
    - b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.
  6. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category D, E or F that are positively attached to the structure, provided that either:
    - a.  $I_p = 1.0$ , component weighs 400 lbs or less and its center of mass is 4 ft or less above a floor level, and flexible connections are provided between the components and associated ductwork, piping and conduit: or
    - b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.
  7. Other exemptions as allowed by the Specifications, Codes and Standards referenced herein.

### 1.05 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. The Building Code shall be the version in effect at the time of Bid within the jurisdiction where the Work is located. All other referenced specifications, codes, and standards refer to the version as referenced by the Building Code. If no version is referenced by the Building Code, then the most current issue available at the time of Bid shall be used.

1. 2021 International Building Code
2. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
3. NFPA 13 Standard for Installation of Sprinkler Systems
4. FEMA 412 Installing Seismic Restraints for Mechanical Equipment
5. FEMA 413 Installing Seismic Restraints for Electrical Equipment
6. FEMA 414 Installing Seismic Restraints for Duct and Pipe
7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Seismic Restraint Manual: Guidelines for Mechanical Systems
8. ACI 318 Building Code Requirements for Structural Concrete and Commentary
9. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
10. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

### 1.06 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.

1. Anchorage and bracing submittals for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems that do not have a design for anchorage and bracing provided within the Contract Documents. Submittals shall include the following:
  - a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment, and edge distance requirements to satisfy operational, wind, seismic and

other forces required by the governing Building Code. Details shall also indicate grout, bearing pads, isolators, etc. required for complete installation.

- b. Design calculations, signed and sealed by a Professional Engineer registered in the State of Utah . Design shall include all loads and load combinations required by the governing Building Code. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.
- c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State or Commonwealth in which the project is located, showing specific details of the support design including material, installation, attachments, connection hardware, etc., and the layout and location of all hangers and supports (resisting both gravity and lateral loads), including bracing orientation and direction of force(s) to be resisted.
- d. Seismic loads and requirements are not required to be included in design for anchorage and bracing of components which are exempt in accordance with Section 1.04B.
- e. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.1.f below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.
- f. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.

## **1.07 DESIGN REQUIREMENTS**

- A. Mechanical fasteners used to secure nonstructural components shall meet the requirements of Section 05 05 23 – Metal Fastening. Post-installed concrete anchors shall be prequalified for use in seismic applications.
- B. No reaction loads (either vertical or lateral) from nonstructural component anchorage and bracing shall be allowed on any element where design has been delegated unless the additional loads on the element have been coordinated with the delegated designer and the submittal is accompanied by a sealed letter from the delegated designer indicating the element has been designed to support the reaction loads.
- C. Reaction loads from nonstructural component anchorage and bracing shall be transferred directly to the primary structural members (girders, beams, etc.), with no components supported from secondary members (purlins, bracing, etc.) unless otherwise approved.

- D. No holes shall be drilled into any structural steel for attachment of component supports without prior approval of the Engineer.
- E. Attachments of nonstructural component anchorage and bracing that cause overstressing of any structural element shall not be permitted.
- F. Seismic Requirements
  - 1. Seismic anchorage and bracing for nonstructural components shall be subject to the current local Building Code in conjunction with the seismic provisions of the International Building Code (IBC) Section 1613 and referenced ASCE 7 Chapter 13.
  - 2. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight (as defined by ASCE 7) of the structure it is attached to, the component shall be classified as a nonbuilding structure for purposes of seismic design. Seismic design for nonbuilding structures shall comply with Building Code requirements in conjunction with the provisions of ASCE 7 Chapter 15.
  - 3. Nonstructural components shall be assigned to the same Seismic Design Category as the structure they occupy or to which they are attached. Design of seismic support system and anchorage shall incorporate the site-specific seismic criteria and submitted to engineer for review. Criteria shall include site-specific spectral response coefficients, Site Class, Seismic Design Category, and Risk Category.
  - 4. Component Importance Factor  $I_p$  shall be 1.5 for all essential nonstructural components noted in item 1.03.E above. All other nonstructural components shall utilize  $I_p = 1.0$  unless noted otherwise.
  - 5. Components shall be anchored and braced for earthquake forces both in the vertical and each orthogonal direction. Seismic anchorage and bracing shall limit deflections of components per ASCE 7, and the displacements shall not impede component functionally and containment.
  - 6. Anchorage design shall account for disparate seismic response behavior of supporting structures. Seismic supports or bracing shall not cross structural expansion joints. Nonstructural components shall not be attached to multiple structural elements which may respond differently during a seismic event without provisions to accommodate independent movement. Flexible expansion loops or offsets, flexible joints, bellows type pipe expansion joints, couplings, etc. shall be provided at structure expansion joints to allow for independent structure movement and thermal movement of piping, ductwork, and conduit. Minimum movement

capability in the vertical and each orthogonal direction shall equal the width of the joint.

7. Provide flexible connections, piping, conduit, etc. at foundation levels where below grade utilities enter the structure.
  8. Design of support system for components with multiple attachments shall consider the stiffness and ductility of the supporting members. Equipment designed as free-standing shall only be attached at its base. Use of non-free-standing equipment requiring both vertical and lateral attachment is contingent upon loads applied to the structure and requires approval by the Engineer.
  9. The seismic anchorage and bracing design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from the specifications or the approved equipment manufacturer. The equipment manufacturer shall verify the attachment points on the equipment can safely withstand the combination of seismic, self-weight and other loads imposed.
- G. Powder actuated fasteners in steel or concrete shall not be used for sustained tension loads in Seismic Design Categories D, E or F unless approved for seismic loading or specifically exempted by ASCE 7. Powder actuated fasteners in masonry shall not be used unless approved for seismic loading regardless of Seismic Design Category.
- H. Friction clips shall not be used in Seismic Design Categories D, E or F for supporting sustained tension loads in combination with resisting seismic forces. C-type and large flange clamps may be used for hanger attachments provided restraining straps meeting NFPA 13 requirements are utilized and loosening of threaded connections is prevented by lock nuts, burred threads, etc.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Anchorage and bracing of nonstructural components shall be constructed of appropriate materials and connecting hardware to provide a continuous load path between the component and supporting structure of sufficient strength and stiffness to resist the calculated design seismic forces and displacements.
- B. Component anchorage, bracing and connection materials shall be compatible with and in general match the component and component gravity support materials. Contact between dissimilar metals shall be prevented.

**PART 3 – EXECUTION**

**3.01 INSTALLATION OF ANCHORAGE AND BRACING**

- A. No anchorage and bracing of nonstructural components shall be installed prior to review and acceptance by the Engineer and permitting agency.
- B. Equipment shall be installed per the manufacturer's recommendations. Fasteners shall meet manufacturer's requirements.
- C. Following installation, all anchorage and bracing and seismically qualified equipment shall be inspected. See Section 01 45 33 – Special Inspections for requirements.

**END OF SECTION**

**SECTION 01 74 00**  
**CLEANING AND WASTE MANAGEMENT**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Administrative and procedural requirements for progress and closeout cleaning at the Site.
  - 1. Contractor shall execute cleaning during the Project, at completion of the Work, and as required by the General Conditions and this Section.
  - 2. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.
- B. Administrative and procedural requirements for disposing of non-hazardous excavation and construction waste.
  - 1. Contractor shall comply with the requirements and procedures for construction waste management and disposal, including developing and implementing a plan for construction waste management and disposal.
  - 2. Extent of required construction waste management and disposal includes within the Project limits, as shown or indicated.

**1.02 REFERENCES**

- A. Definitions:
  - 1. “Waste Management Coordinator” is the person responsible for implementing, monitoring, and reporting the status of the Waste Management Plan. Although available for other assignments, the Waste Management Coordinator shall be present at the Site full time for the duration of the Work.
  - 2. “Construction waste” is building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
  - 3. “Demolition waste” is building and site improvement materials resulting from demolition or selective demolition operations.
  - 4. “Disposal” is removal to an off-Site location of demolition and construction waste and subsequent sale, recycling, reuse, or disposal in a landfill or incinerator



conforming to Laws and Regulations and acceptable to authorities having jurisdiction.

- B. Reference Standards: NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations

### 1.03 ADMINSTRATIVE REQUIREMENTS

- A. Waste Management Plan:

1. General: Develop preliminary plan consisting of waste identification. Indicate quantities by weight or volume. Use the same units of measure throughout waste management plan.
2. Waste Identification: Indicate anticipated types and quantities of excavation waste generated by the Work.
3. Waste Reduction Work Plan: List each type of waste and whether waste will be disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
  - a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in the Work, describe methods for preparing salvaged materials before incorporating them into the Work.
  - b. Disposed Materials: Provide information on how and where materials will be disposed. Include name, address, and telephone number of each landfill and incinerator facility that will be used.
  - c. Handling and Transportation Procedures: Provide information on the method(s) that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location at the Site where materials separation will be located.

- B. Failure of Contractor to Maintain Clean Site and Waste Management Plan:

1. Owner will provide written notification to Contractor for failure to maintain a clean Site and waste management plan.
2. Written notification shall provide five (5) days for Contractor to remedy Site cleaning and waste management to the Engineer's and Owner's satisfaction.
3. Following the five (5) day remedy period, Owner shall without prejudice to any other rights provide services to clean Site to the satisfaction of Owner and

Engineer. Contractor shall be responsible for reimbursement of Owner's costs and expenses for the cleaning work.

#### **1.04 SUBMITTALS**

A. Action/Informational Submittals:

1. Preliminary Waste Management Plan: Prepare in accordance with this Section and submit within 14 days of the Notice to Proceed and prior to removing waste from the Site.
2. Final Waste Management Plan: Submit within 14 days of receiving Engineer's comments on the preliminary waste management plan.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Replace loaded containers with empty containers as demand requires.
- B. Deposit recyclable materials in containers free from debris.
- C. Transport and deposit waste in containers to minimize dust. Close container covers immediately after materials are deposited.

### **PART 2 – PRODUCTS (NOT USED)**

### **PART 3 – EXECUTION**

#### **3.01 PROGRESS CLEANING**

- A. General: Clean the Site, work areas, and other areas occupied by Contractor at least weekly. Dispose of materials in accordance with the General Conditions and the following:
  1. Comply with NFPA 241 for removing combustible waste materials and debris.
  2. Do not hold non-combustible materials at the Site more than three days if the temperature is expected to rise above 80 degrees F. When temperature is less than 80 degrees F, dispose of non-combustible materials within seven days of their generation.
  3. Provide suitable containers for storage of waste materials and debris.
  4. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

**B. Work Areas:**

1. Clean areas where the Work is in progress to level of cleanliness necessary for proper execution of the Work.
2. Remove liquid spills promptly and immediately report spills to Owner, Engineer, and authorities having jurisdiction.
3. Where dust would impair proper execution of the Work, broom-clean or vacuum entire work area, as appropriate.
4. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

C. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of material or equipment installed, using only cleaning agents and methods specifically recommended by material or equipment manufacturer. If manufacturer does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage exposed surfaces.

D. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.

**E. Cutting and Patching:**

1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
2. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

F. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering where required for protection from damage or deterioration, until Substantial Completion.

G. Clean completed construction as frequently as necessary throughout the construction period.

**3.02 CLOSEOUT CLEANING**

A. Complete the following prior to requesting inspection for Substantial Completion:

1. Clean and remove from the Site rubbish, waste material, debris, and other foreign substances.

2. Sweep paved areas broom-clean. Remove petrochemical spills, stains, and other foreign deposits.
3. Hose-clean sidewalks and loading areas.
4. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
5. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to pre-construction condition.
6. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
7. Leave the Site clean, and in neat, orderly condition, satisfactory to Owner and Engineer.

### **3.03 WASTE MANAGEMENT IMPLEMENTATION**

- A. General: Implement the waste management plan approved by Engineer. Provide handling, containers, storage, signage, transportation, and other items required to implement the waste management plan during the Project.
- B. Training: Train all installers, Subcontractors, and Suppliers as required on proper waste management procedures required for the Work.
  1. Distribute the waste management plan as required within three days of Engineer's approval.
  2. Distribute the waste management plan to Contractor's personnel, Subcontractors, and Suppliers prior to these entities starting the Work. Review with installers, Subcontractors, and Suppliers the waste management plan's procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent facilities. Designate and label specific areas of the Site necessary for separating materials to be disposed.

### **3.04 WASTE DISPOSAL**

- A. General: Except for items or materials to be recycled, or otherwise reused, remove waste materials from the Site and properly dispose of waste in facility such as permitted landfill or incinerator or other method acceptable to authorities having jurisdiction.

1. Except as otherwise specified, remove from the Site all waste and debris from the Work as it accumulates. Upon completion of the Work, remove materials, equipment, waste, and debris and leave the Site clean, neat, and orderly. Comply with the Contract Documents regarding cleaning and removal of trash, debris, and waste.
  2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  3. Properly dispose of waste materials, surplus materials, debris, and rubbish off the Site.
  4. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers or sanitary sewers.
  5. Do not discharge wastes into surface waters or drainage routes.
- B. Burying: Do not bury rubbish and waste materials at the Site.
- C. Burning: Do not burn waste materials at the Site.
- D. Disposal: Transport waste materials to proper location at site other than Owner's property for disposal in accordance with Laws and Regulations. Contractor shall be solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste.

**END OF SECTION**

**SECTION 01 75 00**  
**CHECKOUT AND STARTUP PROCEDURES**

**PART 1 – GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Checkout of products and equipment.
  - 2. Startup procedures of products and equipment
- B. Contractor shall initially start up and place equipment installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
- C. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
- D. Provide chemicals, lubricants, and other required operating fluids.
- E. General activities include:
  - 1. Cleaning, as required under other provisions of the Contract Documents.
  - 2. Removing temporary protective coatings.
  - 3. Checking and correcting (if necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
  - 4. All adjustments required.

**1.02 ADMINISTRATIVE REQUIREMENTS**

- A. Definitions:
  - 1. Displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in distance per time, velocity and acceleration of the vibration cycle. Displacement, velocity and acceleration shall be measured by instruments/equipment equal to IRD Mechanalysis, Bentley, Nevada.
- B. Coordination:

1. Coordinate checkout and start-up with other contractors performing Work at the Site.
  2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
  3. Responsibility for proper operation is by Contractor.
  4. Supplier shall be present during checkout, start-up, and initial operation, except as otherwise specified.
  5. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by Contractor, in accordance with Section 01 78 23 – Operations and Maintenance Data.
- C. Contractor's Requirements Prior to Owner's Responsibility:
1. Owner will assume responsibility for the equipment upon Substantial Completion.
  2. Prior to turning over to Owner responsibility for operating and maintaining system or equipment shall be in accordance with this Section and the following requirements:
    - a. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23 – Operations and Maintenance Data.
    - b. Complete system field quality control testing in accordance with the Contract Documents including, but not limited to, the following:
      - 1) Start-up certification shall be performed and completed by the equipment Supplier for the equipment and material prior to be placed into intended use by Owner as specified in the Contract Documents.
      - 2) Equipment and material shall be operated for a minimum 30-day operational period to verify performance. In addition to specific requirements specified in the individual specification sections, process data that is recorded in the PLC shall be submitted to the Engineer in tabular format showing hourly process performance data. A log of all alarms shall also be submitted, along with notes describing corrective measures applied in response to alarm condition.
      - 3) If equipment and material does not perform satisfactorily during the 30-day operational period, then the warranty period start shall be delayed until satisfactorily performance is verified.

- a) Contractor shall repair or replace equipment and material that does not perform satisfactorily at no cost to Owner.
- b) Contractor shall furnish all equipment and material, labor, and incidentals necessary to provide equipment and material to the performance level required by the Contract Documents.
- c. Obtain from Engineer final certificate of Substantial Completion for either entire Work or the portion being turned over to Owner.

### **1.03 SUBMITTALS**

- A. Startup Schedule: Detailed summary of schedule, duration, manpower requirement, and Contractor's means and methods for startup.
- B. Vibration testing results
- C. Closeout Submittals: Manufacturer's certification of installation in accordance with this Section.
- D. Startup testing and operational demonstration performance data.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION**

### **3.01 PRELIMINARY REQUIREMENTS**

- A. Prior to the start-up of the facilities, Contractor shall have prepared and tested all equipment, subsystems and systems in accordance with the requirements of the individual Specification Section to check its ability for sustained operation, including inspections and adjustments by Manufacturer's representative.
- B. Contractor shall develop and submit schedule in accordance with this Section.
- C. After the facilities are sufficiently complete to permit start-up, Contractor shall furnish licensed operator to start-up the facilities. Contractor will be responsible for startup of all facilities constructed under this Contract. During the initial start-up period the Contractor shall check and provide for mechanical operation in accordance with the Contract Documents.

### **3.02 FIELD QUALITY CONTROL**

- A. Manufacturers' Field Services:



1. When specified, furnish services of factory trained representatives of material and equipment manufacturers as specified, including supervising installation, adjusting, checkout, start-up, and testing of materials and equipment.
2. Certification:
  - a. When services by manufacturer are required at the Site, within 14 days after first test operation of equipment, submit to Engineer a letter from manufacturer, on manufacturer's letterhead, stating that materials and equipment are installed in accordance with manufacturer's requirements and installation instructions, and in accordance with the Contract Documents.
  - b. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.
3. Manufacturer shall bring any discrepancies to the immediate attention of the Contractor for correction. Contractor shall promptly correct any discrepancies noted by the Manufacturer. Manufacturer shall coordinate correction of discrepancies with the Contractor. Discrepancies and their correction shall be noted in inspection records and in all required reports. Any corrections that result in changes to the work as shown on the Contract Documents shall be approved by the Engineer prior to their execution.

### **3.03 SYSTEM START-UP**

- A. Equipment and materials shall be provided in conformance with the manufacturer's installation instructions and in accordance with the Contract Documents.
- B. Provide start-up services as specified in the individual Specification Sections.
- C. Contractor shall furnish consumables required for startup including, but not limited to, electricity, water, chemicals and lubrication. Contractor shall provide a plan for disposal of water used for testing unless otherwise specified in the Contract Documents.
- D. General system requirements:
  1. Start-up of the plant by Contractor shall include all mechanical systems, including but not limited to, pumps, compressors, and like equipment, and the ventilating, air conditioning (or heating), plumbing, and electrical systems. Start-up of either the heating or air conditioning systems is dependent upon the time of year that the plant start up is initiated. Contractor will be required to return at the beginning of the next heating or air conditioning season (whichever is applicable) to start the appropriate system.
  2. Cleaning as required under provisions of the Contract Documents.
  3. Remove temporary protective coatings.

4. Flushing and replacing greases and lubricants as required by Manufacturer
5. Lubrication.
6. Verify the following:
  - a. Shaft and coupling alignments and reset where needed.
  - b. Set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
  - c. Leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping, conduits and ducts that may apply stress on equipment.
7. Valves:
  - a. Tighten packing glands to ensure no leakage but allow valve stems to operate without galling.
  - b. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
  - c. Replace packing on valves that continue to leak.
  - d. Remove and repair bonnets that leak.
  - e. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
8. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.
9. Tighten flanges and other pipe joints after system has been placed in operation.
10. Replace gaskets that show signs of leakage after tightening.
11. Inspect all joints for leakage:
  - a. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
  - b. Clean threads on both parts and apply compound and remake joints.
12. After system has been placed in operation, clean valve seats and headers in fluid system to ensure freedom from foreign matter.
13. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.

14. Repair damaged insulation.

**END OF SECTION**

**SECTION 01 78 23**  
**OPERATION AND MAINTENANCE DATA**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Requirements for operation and maintenance data, manuals, and documentation.
  - 1. Submit operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, as instructional and reference manuals by operations and maintenance personnel at the Site.
  - 2. Required operation and maintenance data groupings are listed in this Section. At minimum, submit operation and maintenance data for:
    - a. All equipment and systems
    - b. Valves, gates, actuators, and related accessories
    - c. Instrumentation and control devices
    - d. Electrical gear
  - 3. For each operation and maintenance manual, submit the following:
    - a. Preliminary Submittal: Printed and bound copy of entire operation and maintenance manual or electronic copy, except for test data and service reports by Supplier.
    - b. Final Submittal: Printed and bound copy of complete operations and maintenance manual and electronic copy, including test data and service reports by Supplier.

**1.02 ADMINISTRATIVE REQUIREMENTS**

- A. Quantity Required and Timing of Submittals:
  - 1. Preliminary Submittal:

- a. Printed Copies: One copy, exclusive of copies required by Contractor.
  - b. Electronic Copies: One copy.
  - c. Submit to Engineer, whichever occurs first:
    - 1) 60 days prior to starting training of operations and maintenance personnel.
    - 2) 30 days prior to field quality control testing at the Site.
  - d. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by Engineer, before associated materials and equipment will be eligible for payment.
2. Preliminary Submittal shall be reviewed by Engineer. One printed or electronic copy shall be returned to Contractor with required revisions noted.
  3. Final Submittal: Provide 14 days prior to checkout and startup procedures specified in Section 01 75 00 – Checkout and Startup Procedures, unless Submittal is specified as required prior to an interim Milestone.
    - a. Printed Copies: Two copies.
    - b. Electronic Copies: One copy.
- B. Format of Printed Copies:
1. Binding and Cover:
    - a. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
    - b. Provide the following information on cover of each volume:
      - 1) Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”.
      - 2) Name or type of material or equipment covered in the manual.

- 3) Volume number, if more than one volume is required, listed as "Volume \_\_\_ of \_\_\_", with appropriate volume-designating numbers filled in.
    - 4) Name of Project and, if applicable, Contract name and number.
    - 5) Name of building or structure, as applicable.
  - c. Provide the following information on spine of each volume:
    - 1) Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
    - 2) Name or type of material or equipment covered in the manual.
    - 3) Volume number, if more than one volume is required, listed as "Volume \_\_\_ of \_\_\_", with appropriate volume-designating numbers filled in.
    - 4) Project name and building or structure name.
2. Drawings:
  - a. Bind into the manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing.
  - b. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include no more than three drawing sheets per pocket.
3. Copy Quality and Document Clarity:
  - a. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color.
  - b. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content.
4. Organization:

- a. Provide table of contents in each volume for each chapter or section.
- b. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

C. Format of Electronic Copies:

1. Each electronic copy shall include all information included in the corresponding printed copy.
2. Submit electronic copy via transferable method and format acceptable to Engineer.
3. File Format:
  - a. Acceptable formats include Adobe PDF, Microsoft Word, Autodesk DWF, and AutoCAD.
  - b. Files shall be electronically searchable.
  - c. Submit separate file for each separate document in the printed copy.
  - d. Within each file, provide bookmarks for the following:
    - 1) Each chapter and subsection listed in the corresponding printed copy document's table of contents
    - 2) Each figure
    - 3) Each table
    - 4) Each appendix
4. Submit drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", ".gif", ".dwf", or ".dwg".

D. General Content Requirements:

1. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings as applicable, bills of materials, technical bulletins, installation and handling requirements, maintenance and repair instructions, and other information

required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.

2. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
3. Submit written explanations of all safety considerations relating to operation and maintenance procedures.
4. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
  - a. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
  - b. Recommended schedule for each preventive maintenance task.
  - c. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
  - d. Table of alternative lubricants.
  - e. Troubleshooting instructions.
  - f. List of required maintenance tools and equipment.
5. Submit complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:



- a. Manufacturer's name, address, telephone number, fax number, and Internet website address.
  - b. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
  - c. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
  - d. For each part or piece include the following information:
    - 1) Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
    - 2) Part name or description.
    - 3) Manufacturer's part number.
    - 4) Quantity of each part used in each assembly.
    - 5) Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
6. Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number).
  7. Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
  8. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other

means of obliterating information that does not apply to the materials and equipment furnished.

9. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
10. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
11. Submit copy of warranty bond and service contract as applicable.
12. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

### **1.03 SUBMITTALS**

- A. Action/Informational Submittals: Submit preliminary schedule (listing) of operations and maintenance data for Engineer's review. Preliminary operations and maintenance data shall be grouped as major equipment and material systems and divided into sub-systems as required for clarity, subject to Engineer's approval.
- B. Closeout Submittals:
  1. Operation and maintenance data: Submit the operations and maintenance data indicated in the Contract Documents, grouped into submittals as approved by Engineer.

### **PART 2 – PRODUCTS (NOT USED)**

### **PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 78 39**  
**PROJECT RECORD DOCUMENTS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. Requirements for recording changes to record documents.
2. Requirements for electronic files furnished by Engineer.

B. Contractor shall maintain and submit to Engineer with record documents in accordance with the Specifications, General Conditions, and Supplementary Conditions.

**1.02 ADMINISTRATIVE REQUIREMENTS**

A. Maintenance of Record Documents:

1. The following record documents shall be maintained in the Contractor's field office:
  - a. Drawings, Specifications, and Addenda.
  - b. Shop Drawings, Samples, and other Contractor submittals, including records of test results, approved or accepted as applicable, by Engineer.
  - c. Change Orders, Work Change Directives, Field Orders, photographic documentation, survey data, and all other documents pertinent to the Work.
2. Update record documents on a monthly basis, minimum.
3. Provide files and racks for proper storage and easy access to record documents.
4. Make record documents available for inspection upon request of Engineer or Owner.
5. Do not use record documents for purpose other than serving as Project record. Do not remove record documents from Contractor's field office without Engineer's approval.

B. Submittal of Record Documents:

1. Submit to Engineer the following record documents: Drawings.

2. Prior to readiness for final payment, submit to Engineer one copy of final record documents. Submit complete record documents; do not make partial submittals.
3. Submit record documents with transmittal letter on contractor letterhead complying with letter of transmittal requirements in Section 01 33 00 – Submittal Procedures.
4. Record documents submittal shall include certification, with original signature of official authorized to execute legal agreements on behalf of Contractor.

C. Electronic Files Furnished by Engineer:

1. CADD files will be furnished by Engineer upon the following conditions:
  - a. Contractor shall submit to Engineer a letter on Contractor letterhead requesting CADD files and providing specific definition(s) or description(s) of how files will be used, and specific description of benefits to Owner (including credit proposal, if applicable) if the request is granted.
  - b. Contractor shall execute Engineer's standard agreement for release of electronic files and shall abide by all provisions of the agreement for release of electronic files.
  - c. Layering system incorporated in CADD files shall be maintained as transmitted by Engineer. CADD files transmitted by Engineer containing cross-referenced files shall not be bound by Contractor. Drawing cross-references and paths shall be maintained. If Contractor alters layers or cross-reference files, Contractor shall restore all layers and cross-references prior to submitting record documents to Engineer.
  - d. Contractor shall submit record drawings to Engineer in same CADD format that files were furnished to Contractor.

### 1.03 SUBMITTALS

- A. Closeout Submittals: Provide record documentation as specified in this Section.

**PART 2 – PRODUCTS (NOT USED)****PART 3 – EXECUTION****3.01 GENERAL REQUIREMENTS:**

- A. At the start of the Project, label each record document to be submitted as, “PROJECT RECORD” using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
- B. Keep record documents current. Make entries on record documents within two working days of receipt of information required to record the change.
- C. Do not permanently conceal the Work until required information has been recorded.
- D. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Engineer-accepted record documents.
- E. Marking of Entries:
  - 1. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.
  - 2. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files.
  - 3. Date all entries on record documents.
  - 4. Call attention to changes by drawing a “cloud” around the change(s) indicated.
  - 5. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

**3.02 RECORDING CHANGES TO DRAWINGS:**

- A. Record changes on copy of the Drawings. Submittal of Contractor-originated or -produced drawings as a substitute for recording changes on the Drawings is unacceptable.
- B. Record changes on plans, sections, schematics, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.

C. Record actual construction including:

1. Depths of various elements of foundation relative to Project datum.
2. Field changes of dimensions, arrangements, and details.
3. Changes made in accordance with Change Orders, Work Change Directives, and Field Orders.
4. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document changes.

**3.03 RECORDING CHANGES FOR SCHEMATIC LAYOUTS:**

- A. In some cases, on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Contractor subject to acceptance by Engineer.
- B. Record on record documents all revisions to schematics on Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Contract. Record actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
- C. When dimensioned plans and dimensioned sections on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items
  1. Clearly identify the Work item by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.
  2. Show by symbol or note the vertical location of Work item; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping not embedded, also provide elevation dimension relative to Project datum.
  3. Descriptions shall be sufficiently detailed to be related to Specifications.
- D. Engineer may furnish written waiver of requirements relative to schematic layouts shown on plans and sections when, in Engineer’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on waiver(s) being issued.

**3.04 REQUIREMENTS FOR SUPPLEMENTAL DRAWINGS:**

- A. In some cases, drawings produced during construction by Engineer or Contractor supplement the Drawings and shall be included with record documents submitted by Contractor. Supplemental record drawings shall include drawings provided with Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings due to space limitations.
- B. Supplemental drawings provided with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.
- C. When supplemental drawings developed by Contractor using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings in AutoCAD (latest version) as part of record drawing submittal.

**3.05 RECORDING CHANGES TO SPECIFICATIONS AND ADDENDA:**

- A. Mark each Section to record:
  - 1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually provided.
  - 2. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

**3.06 RECORDING CHANGES TO DRAWING MODELS**

- A. Record changes on Engineer supplied electronic models to generate record drawings.
- B. Record changes on plans, sections, schematics, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.
- C. Record actual construction including:
  - 1. Field changes of dimensions, arrangements, and details.
  - 2. Changes made in accordance with Change Orders, Work Change Directives, and Field Orders.
  - 3. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document changes.

- D. When required, electronic models shall be updated with as-built asset information in accordance with the Contract Documents. Asset information shall be entered and coordinated with electronic model files. Asset information includes equipment, instrumentation, and appurtenance tagging, pipe and valve identification information, and Owner identified equipment and material.

**END OF SECTION**



**SECTION 01 78 43**  
**SPARE PARTS AND EXTRA MATERIAL**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Contractor shall furnish spare parts data and extra materials for materials and equipment in accordance with the Contract Documents.
- B. Spare Parts and Extra Materials:
1. Provide spare parts, extra stock materials, maintenance supplies, and special tools required for maintenance (“spare parts and extra materials”) for one year of operation (unless otherwise specified in the individual Specification Section).
    - a. Provide Supplier recommended lubricating oil and grease in accordance with this Section and the Contract Documents.
  2. Provide list of Supplier recommended spare parts and extra material.
    - a. Include list of four standard lubricants, minimum, that shall be interchangeable for each type of lubricant required in the Contract Documents.
    - b. Include unit prices in current United States funds
    - c. Source(s) of supply for each.
- C. Packaging and Labeling:
1. Furnish spare parts and extra materials in manufacturer’s unopened cartons, boxes, crates, or other original, protective covering suitable for preventing corrosion and deterioration for maximum length of storage normally anticipated by manufacturer.
  2. Packaging of spare parts and extra materials shall be clearly marked and identified with name of manufacturer, applicable equipment, part number, part description, and part location in the equipment.
  3. Protect and package spare parts and extra materials for maximum shelf life normally anticipated by manufacturer.
- D. Finishes: Spare parts and extra material shall have painting, protective coating, and finishes identical to original installed equipment and material. Where painting, protective

coating, or finishes are not specified, suitable provisions shall be furnished to protect from corrosion.

- E. Special Tools: Contractor shall provide special tools necessary to operate, disassemble, service, repair, and adjust equipment and material in accordance with the manufacturer's operation and maintenance manual. Special tool requirements shall be the same as spare parts and extra material specified in this Section.
- F. Storage Prior to Delivery to Owner: Prior to furnishing spare parts and extra materials to Owner, store spare parts and extra materials in accordance with the Contract Documents and manufacturers' recommendations.
- G. Delivery Time and Eligibility for Payment:
  - 1. Deliver to Owner spare parts and extra materials prior to date of Substantial Completion for equipment or system associated with the spare parts and extra materials. Do not deliver spare parts and extra materials before commencing start-up for associated equipment or system.
  - 2. Spare parts and extra materials are not eligible for payment until delivered to Owner and Contractor's receipt of Owner's countersignature on letter of transmittal.
- H. Procedure for Delivery to Owner:
  - 1. Deliver spare parts and extra materials to Owner's permanent storage rooms at the Site or area(s) at the Site designated by Owner.
  - 2. When spare parts and extra materials are delivered, Engineer and Owner will mutually inventory the spare parts and extra materials delivered to verify compliance with the Contract Documents regarding quantity and part numbers.
  - 3. Additional procedures for delivering spare parts and extra materials to Owner, if required, will be developed by Engineer and complied with by Contractor.
- I. Transfer Documentation:
  - 1. Furnish on Contractor letterhead a letter of transmittal for spare parts and extra materials furnished under each Specification Section. Letter of transmittal shall accompany spare parts and extra materials. Do not furnish letter of transmittal separate from associated spare parts and extra materials.
  - 2. Furnish three original, identical, signed letters of transmittal for each Specification Section. Upon delivery of specified quantities and types of spare parts and extra materials to Owner, designated person from Owner will countersign each original letter of transmittal indicating Owner's receipt of spare parts and extra materials.

- a. Owner will retain one fully signed original.
  - b. Contractor shall submit one fully signed original to Engineer.
  - c. Contractor shall retain one fully signed original for Contractor's file.
3. Letter of transmittal shall include the following:
- a. Information required for letters of transmittal in Section 01 33 00 – Submittal Procedures.
  - b. Transmittal shall list spare parts and extra materials furnished under each Specification Section. List each individual part or product and quantity furnished.
  - c. Provide space for countersignature by Owner as follows: space for signature, space for printed name, and date.
- J. Contractor shall be fully responsible for loss or damage to spare parts and extra materials until spare parts and extra materials are received by Owner.

## **1.02 SUBMITTALS**

- A. Action/Informational Submittals: Individual Specification Sections that require spare parts, extra material, or tools, Contractor shall submit inventory checklist for each individual Specification Section that includes the following information:
1. Specification Section number and title.
  2. Name of spare parts, extra material, or tools.
  3. Manufacturer, part number and description.
  4. Quantity specified and furnished.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 01 79 00**  
**INSTRUCTION OF OWNER'S PERSONNEL**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Contractor shall furnish services of operation and maintenance training specialists to instruct Owner's personnel in recommended operation and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
- B. Contractor shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
- C. Owner reserves the right to record training sessions on video for Owner's later use in instructing Owner's personnel.

**1.02 ADMINISTRATIVE REQUIREMENTS**

- A. Definitions:
  - 1. Training -Manufacturer's verbal, visual, and written presentation of materials to Owner's staff to ensure that any Owner personnel undergoing training understand the Manufacturer's recommended procedures to properly operate and maintain the equipment and systems for the expected service life.
- B. Qualifications:
  - 1. Contractor's instructors shall be factory-trained by manufacturer of material or equipment.
  - 2. Contractor's instructors shall be proficient and experienced in conducting training of type required.
  - 3. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, furnish services of replacement instructor with acceptable qualifications.
- C. Scheduling:
  - 1. General:
    - a. Contractor shall coordinate training services with start-up and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner, in accordance with the Contract Documents.

- b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Furnish training services at the required days and times at no additional cost to Owner.
  - c. Prerequisites to Training: Training of Owner's personnel shall commence after acceptable preliminary operation and maintenance data has been submitted and work required in Section 01 75 00 – Checkout and Startup Procedures is complete.
2. Training Schedule Submittal:
- a. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer and Owner. Proposed training schedule shall show all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training, number of training sessions, and scheduling.
  - b. Timing of Training Schedule Submittal: Submit initial training schedule at least thirty days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with Engineer's comments, no later than seven days prior to starting the first training session.
  - c. Owner reserved the right to modify personnel availability for training in accordance with process or emergency needs at the Site.

### 1.03 TRAINING REQUIREMENTS

#### A. General Lesson Plan Requirements:

1. Contractor's lesson plan shall describe specific instruction topics, system components for which training will be furnished, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.
2. Submit acceptable lesson plan 14 days prior to starting associated training.
3. Lesson plan shall include estimated duration of each training segment.

#### B. Specific Lesson Plans Requirements:

1. Equipment overview shall cover the following:

- a. Equipment's operating (process) function, performance objectives, and fundamental operating principles.
  - b. Equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
  - c. Support equipment and appurtenances.
  - d. Safety and potential hazards.
  - e. Safety and control interlocks.
2. Operations personnel training shall cover the following:
- a. Equipment overview: As described in this Section.
  - b. Operation:
    - 1) Principles, operating, start-up, and shutdown procedures.
    - 2) Abnormal or emergency start-up, operating, and shutdown procedures.
    - 3) Alarm conditions and responses.
    - 4) Monitoring and recordkeeping.
    - 5) Housekeeping.
  - c. Troubleshooting: Required corrective maintenance or an operating parameter adjustment.
3. Maintenance personnel training:
- a. Equipment overview: As described in this Section.
  - b. Equipment preventive maintenance:
    - 1) Inspection procedures:
      - a) Operation.
      - b) Trouble symptoms and anticipate breakdowns.
      - c) Predictive maintenance.
    - 2) Preventative maintenance intervals.

- 3) Lubricant and replacement parts.
  - 4) Cleaning practices and intervals.
  - 5) Special tools required.
  - 6) Removal, installation, and disassembly and assembly procedures.
  - 7) “Hands-on” demonstrations of preventive maintenance procedures.
  - 8) Measuring instruments and procedures
  - 9) Torqueing, mounting, calibrating, and aligning procedures and settings requirements.
  - 10) Check and test equipment following corrective maintenance.
4. Equipment Troubleshooting:
- a. Systematic troubleshooting procedures.
  - b. Checklists.
  - c. Testing and diagnostic procedures.
  - d. Corrective maintenance procedures with “hands on” demonstrations.
- C. Training Aids:
1. Contractor’s instructor shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:
    - a. Audio-visual aids
    - b. Equipment cutaways and samples
    - c. Tools, including special tools
  2. Podium presentation aids: Presentation shall cover equipment, products and materials provided. Provide electronic version of presentation material to Engineer.
    - a. Electronic version of presentation aids shall be Microsoft PowerPoint or equivalent format.
    - b. Presentation shall include the following sections:

- 1) Complete system overview including, but not limited to, related and associated equipment specific to the system.
  - 2) Specific equipment requirements and how equipment functions within the overall system.
  - 3) Site specific system and equipment requirements.
- c. Hardcopy handouts of the electronic presentation aids shall be provided prior to each training session for review during podium presentation.
3. Handouts:
- a. Contractor's instructor shall distribute and use descriptive handouts during training.
  - b. Handouts should be coordinated with the instruction
  - c. Provide at least ten copies of handouts for each training session
4. Audio-visual Equipment: Training provider shall provide audio-visual equipment required for training sessions.

#### **1.04 SUBMITTALS**

A. Action/Informational Submittals:

1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule submittals in accordance with timeframes specified in this Section.
2. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with the Contract Documents. Lesson plan shall comply with requirements of this Section. Include with lesson plan copy of handouts that will be used during training sessions. Provide lesson plan submittals in accordance with timeframes specified in this Section.
3. Podium presentation material, electronic version.
4. Qualifications: Credentials of Contractor's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Section and shall include brief resume and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.



**B. Closeout Submittals:**

1. Trainee sign-in sheet for each training session. Submit to Owner's training coordinator.

**C. Quality Assurance Submittals:**

1. **Qualifications:** Credentials of Contractor's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.

**PART 2 – PRODUCTS (NOT USED)****PART 3 – EXECUTION****3.01 “HANDS-ON” DEMONSTRATIONS**

- A. Contractor's instructor shall provide “hands-on” demonstration of operations and maintenance of equipment and materials for each training session.
- B. Contractor shall furnish tools and appurtenances required for demonstrations.

**3.02 SCHEDULE**

- A. Contractor shall furnish the hours of training and number of sessions indicated, at a minimum. Travel time and expenses are the responsibility of the manufacturer and are excluded from required training time indicated in the Contract Documents.
- B. Owner's operations at the Site occur 24 hours per day, divided into three shifts. Training shall be scheduled during day shift, normal working hours unless otherwise approved by Engineer.
- C. Training shall be provided for a minimum of two identical sessions, unless otherwise specified, with each session scheduled for different weeks.

**END OF SECTION**

**SECTION 03 11 00**  
**CONCRETE FORMWORK**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 03 15 00 – Concrete Accessories
- B. Section 03 30 00 – Cast-in-Place Concrete

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. Building Code for the State or Commonwealth in which the project is located.
  - 2. ACI 318 – Building Code Requirements for Structural Concrete
  - 3. ACI 301 – Specifications for Structural Concrete
  - 4. ACI 347 – Recommended Practice for Concrete Formwork
  - 5. U.S. Product Standard for Concrete Forms, Class I, PS 1
  - 6. ACI 117 – Specification for Tolerances for Concrete Construction and Materials and Commentary

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  - 1. Manufacturer's data on proposed form release agent
  - 2. Manufacturer's data on proposed formwork system including form ties

## 1.05 QUALITY ASSURANCE

- A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

## PART 2 – PRODUCTS

### 2.01 FORMS AND FALSEWORK

- A. All forms shall be smooth surface forms unless otherwise specified.
- B. Wood materials for concrete forms and falsework shall conform to the following requirements:
  - 1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.
  - 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.
- C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

### 2.02 FORMWORK ACCESSORIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Sika Corporation or approved equal. Friction fit plugs shall not be used.
- C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface.

Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

## **PART 3 – EXECUTION**

### **3.01 FORM DESIGN**

- A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.
- B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

### **3.02 CONSTRUCTION**

- A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.
- B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.
- C. Forms shall be true to line and grade and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.
- D. Forms shall be mortar tight to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during

placement and vibration of concrete. Such gasket may be a 1 to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form.

- E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.
- G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.
- H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.
- I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.
- J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or

lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

- K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

### **3.03 TOLERANCES**

- A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.
- C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and benchmarks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- D. Regardless of the tolerances specified, no portion of the structure shall extend beyond the legal boundary of the structure.

### **3.04 FORM ACCESSORIES**

- A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.
- B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers to leave the surface of the holes clean and rough before being filled with mortar. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If

steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

**3.05 APPLICATION – FORM RELEASE AGENT**

- A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

**3.06 INSERTS AND EMBEDDED ITEMS**

- A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

**3.07 FORM CLEANING AND REUSE**

- A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

**3.08 FORM REMOVAL AND SHORING**

- A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
- B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

**Ambient Temperature (°F.) During Concrete Placement**

	<b>Over 95°</b>	<b>70°-95°</b>	<b>60°-70°</b>	<b>50°-60°</b>	<b>Below 50°</b>
Edge Forms for Slabs on Grade	1 day	1 day	1 day	1 day	

**Ambient Temperature (°F.) During Concrete Placement**

	Over 95°	70°-95°	60°-70°	50°-60°	Below 50°
Walls	5 days	2 days	2 days	3 days	Do not remove until directed by Engineer (7 days minimum)
Columns	7 days	2 days	3 days	4 days	
Beam Soffits	10 days	7 days	7 days	7 days	
Elevated Slabs	12 days	7 days	7 days	7 days	

- C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.
- D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall always be available for inspection at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

**3.09 RESHORING**

- A. When reshoring is permitted or required the operations shall be planned and subjected to approval by the Engineer.
- B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.
- C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.
- D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and, in all cases, shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.
- E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.



**END OF SECTION**

**SECTION 03 15 00**  
**CONCRETE ACCESSORIES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, crack inducing joint inserts, epoxy bonding agent, and neoprene bearing pads.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 03 30 00 – Cast-in-Place Concrete
- B. Section 07 90 00 – Joint Fillers, Sealants, and Caulking

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
1. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
  2. ASTM D412 – Standard Tests for Rubber Properties in Tension
  3. ASTM D 624 – Standard Test method for Rubber Property - Tear Resistance
  4. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics
  5. ASTM D1751 – Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types)
  6. ASTM D 1752 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
  7. ASTM D 1171 – Standard Test Method for Ozone Resistance at 500 pphm
  8. ASTM D 471 – Standard Test Method for Rubber Properties
  9. ASTM D 2240 – Standard Test for Rubber Property – Durometer Hardness

## 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  - 1. Manufacturer's literature on all products specified herein including material certifications.
  - 2. Proposed system for supporting PVC waterstops in position during concrete placement.
  - 3. Samples of products if requested by the Engineer.

## PART 2 – PRODUCTS

### 2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

- A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.
- B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.
- C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.
- D. The required minimum physical characteristics for this material are:
  - 1. Tensile strength – 1,750 psi (ASTM D-638).
  - 2. Ultimate elongation – not less than 280% (ASTM D-638).
- E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.
- F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.
- G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

## 2.02 RETROFIT WATERSTOPS

- A. Retrofit waterstops shall be used where specifically shown on Drawings for sealing joints between existing concrete construction and new construction.
- B. Retrofit waterstops shall be PVC waterstops fabricated from material as described in Section 2.01 of this Specification.
- C. Retrofit waterstop shall be attached to existing concrete surface as shown on Drawings.
- D. Use of split waterstop in lieu of specially fabricated retrofit waterstop will not be acceptable.
- E. E. Retrofit Waterstop manufacturer must provide a complete system including all Waterstop, stainless steel anchoring hardware, and epoxy for installation.
- F. For construction joints, retrofit waterstop shall be style number 609 by Sika Greenstreak, RF-638 by BoMetals, Inc., or approved equal. For expansion joints, retrofit waterstop shall be style number 667 by Sika Greenstreak, RF-912 by BoMetals, Inc., Type 36RT Retrofit Kit by DuraJoint Concrete Accessories, or approved equal.

## 2.03 CHEMICAL RESISTANT WATERSTOPS

- A. Where specifically noted on Contract Drawings, chemical resistant waterstops shall be used instead of PVC waterstops.
- B. Chemical resistant waterstops for construction joints shall be ribbed with a center bulb. They shall be 6 inches wide with a minimum thickness at any point of 3/16 inches.
- C. Chemical resistant waterstops for expansion joints shall be ribbed tear web. They shall be 9 inches wide with a tear web designed to accommodate 1 inch of free movement minimum.
- D. Chemical resistant retrofit waterstop shall be a minimum of 2½" wide along the ribbed side and a minimum 5" wide along the side attached to the existing concrete surface. Retrofit waterstop shall include a center bulb and shall have a minimum thickness of 3/16". Retrofit waterstop manufacturer shall provide a complete system including waterstop, stainless steel anchoring hardware and epoxy for installation.
- E. Chemical resistant waterstops shall be manufactured from a fully crosslinked thermoplastic vulcanizate rubber.
- F. Waterstops shall be TPER by BoMetals, Inc., Earth Shield TPV/TPE-R by JP Specialties, Inc., Westec TPER by Westec Barrier Technologies, or TPE-R by DuraJoint Concrete Accessories.

**2.04 WATERPROOF MEMBRANE PATCH**

- A. Waterproof membrane patch shall be Sikadur Combiflex by Sika Corporation or approved equal. Minimum width of waterstop material shall be twelve (12) inches unless shown otherwise on Contract Drawings.

**2.05 HYDROPHILIC WATERSTOPS**

- A. Hydrophilic waterstops shall be designed to expand under hydrostatic conditions. For hydrostatic head pressure greater than 25 feet, waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak. For hydrostatic head pressure 25 feet or less, Adeka Ultra Seal KBA-1510FP or Hydrotite CJ-1020-2K shall be used. Concrete cover and confinement requirements shall be in accordance with the manufacturer's recommendations.
- B. Waterstops shall be fabricated from a chemically modified natural rubber product with a hydrophilic agent. Use of bentonite based waterstop material will not be allowed.
- C. Waterstops shall either contain an interior stainless-steel mesh or an interior coextrusion of non-hydrophilic rubber to ensure expansion occurs along the width and thickness of the waterstop thereby restricting the expansion in the longitudinal direction.

**2.06 WATERSTOP ADHESIVE**

- A. Adhesive between waterstops and existing concrete shall be Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond hydrophilic waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-Z by Sika Greenstreak, or approved equal.

**2.07 JOINT SEALANTS**

- A. Joint sealants shall comply with Section 07 90 00 – Joint Fillers, Sealants, and Caulking.

**2.08 EXPANSION JOINT MATERIAL**

- A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:
  - 1. Type I – Sponge rubber, conforming to ASTM D1752, Type I.
  - 2. Type II – Cork, conforming to ASTM D1752, Type II.
  - 3. Type III – Self-expanding cork, conforming to ASTM D1752, Type III.

4. Type IV – Bituminous fiber, conforming to ASTM Designation D1751.

## **2.09 EXPANSION JOINT SEAL**

- A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive, and pressurized during the adhesive cure time.
- B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc.

## **2.10 CRACK INDUCING JOINT INSERTS**

- A. Crack inducing joint inserts shall be Zip-Cap by Greenstreak Plastic Products, Zip-Joint by BoMetals, Inc.

## **2.11 EPOXY BONDING AGENT**

- A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterEmaco ADH Series by Master Builders Solutions.

## **2.12 EPOXY RESIN BINDER**

- A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, MasterEmaco ADH 327 or 327 RS by Master Builders Solutions.

## **2.13 BEARING PADS**

- A. Neoprene bearing pads shall conform to requirements of A4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be nonlaminated pads having a nominal Shore A durometer hardness of 70 in accordance with ASTM D2240. Adhesive for use with neoprene pads shall be an epoxy-resin compound compatible with the neoprene having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikadur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

## **PART 3 – EXECUTION**

### **3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS**

- A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.
- B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.
- C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.
- D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.
- E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.
- F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:
  - 1. Tensile strength less than 80 percent of parent material.
  - 2. Overlapped (not spliced) Waterstop.
  - 3. Misalignment of waterstop geometry at any point greater than 1/16 inch.
  - 4. Visible porosity or charred or burnt material in weld area.

5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

### **3.02 WATERPROOF MEMBRANE PATCH AND HYDROPHILIC WATERSTOPS**

- A. Patches and waterstops shall be installed only where shown on the Drawings.
- B. Patches and waterstops shall be installed in strict accordance with manufacturer's recommendations.

### **3.03 WATERSTOP ADHESIVE**

- A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.
- B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

### **3.04 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS**

- A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.
- B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.
- C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.
- E. Type 1 joint sealant shall be used in all expansion and crack inducing joints in concrete, except where other specific types are required as stated below, and wherever else specified or shown on the Drawings. Sealant shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.



- F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.
- G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

### **3.05 EXPANSION JOINT SEAL**

- A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

### **3.06 CRACK INDUCING JOINT INSERTS**

- A. For joints in slabs, inserts shall be floated in fresh concrete during finishing.
- B. For joints in walls, inserts shall be secured in place prior to casting wall.
- C. Inserts shall be installed true to line at the locations of all joints as shown on the Drawings.
- D. Inserts shall extend into concrete sufficient depth.
- E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

### **3.07 EPOXY BONDING AGENT**

- A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.
- B. Bonding surface shall be clean, sound, and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.
- C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.
- D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

### **3.08 EPOXY RESIN BINDER**

- A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

**3.09 BEARING PADS**

- A. Care shall be taken in fabricating pads and related metal parts so effects detrimental to the proper performance of the pads, such as uneven bearing and excessive bulging, will not occur.

**END OF SECTION**

**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Provide all labor, equipment, materials, and services necessary for the manufacture, transportation, and placement of all plain and reinforced concrete work, as shown on the Drawings or as required by the Engineer.
- B. The requirements in this section shall apply to the types of concrete listed below. See Article 2.11 for concrete mix design and properties of concrete.
1. Class A1 Concrete: Normal weight structural concrete to be used in all structures qualifying as environmental concrete structures designed in accordance with ACI 350 including pump stations, tanks, basins, process structures, and any structures containing fluid or process chemicals, or other materials used in treatment process.
  2. Class A2 Concrete: Normal weight structural concrete in all structures other than environmental concrete structures as described above, and for all sidewalks and pavement.
  3. Class A3 Concrete: Normal weight structural concrete to be used for interior slabs where a Type “D” Steel Troweled Finish or Type “G” Hardened Finish is required. Class A3 concrete shall not contain entrained air.
  4. Class A4 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A4 concrete is identical to Class A2 concrete except that coarse aggregate specified in Article 2.08 below shall be Size #8 in accordance with ASTM C33.
  5. Class A5 Concrete: Normal weight structural concrete used where concrete is indicated to be placed underwater (tremie concrete).
  6. Class A6 Concrete: Normal weight structural concrete to be used for superstructure frames where specifically required on Contract Drawings. Superstructure frames are concrete moment frame structures and include elevated slabs placed integrally with frames. Where concrete frames are placed monolithic with elevated slabs and a Type “D” Steel Troweled or Type “G” Hardened Finish is required for the slabs, Class A6 concrete shall not contained entrained air.

7. Class A7 Concrete: Normal weight structural concrete to be used for superstructure frames where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A7 concrete is identical to Class A6 concrete except that coarse aggregate specified in Article 2.08 below shall be Size #8 in accordance with ASTM C33.
8. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.
9. Class C Concrete: Light weight structural concrete used only where specifically noted on Contract Drawings.

## **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 15 00 – Concrete Accessories

## **1.03 , CODES AND STANDARDS**

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  1. International Building Code
  2. ACI 214 – Guide to Evaluation of Strength Test Results of Concrete
  3. ACI 301 – Specifications for Structural Concrete
  4. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
  5. ACI 305 – Specification for Hot Weather Concreting
  6. ACI 306 – Standard Specification for Cold Weather Concreting
  7. ACI 309R – Guide for Consolidation of Concrete
  8. ACI 318 – Building Code Requirements for Structural Concrete and Commentary
  9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

10. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
11. ASTM C 33 – Standard Specification for Concrete Aggregates
12. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
13. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
14. ASTM C 88 – Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
15. ASTM C 94 – Standard Specification for Ready-Mixed Concrete
16. ASTM C 114 – Standard Test Method for Chemical Analysis of Hydraulic Cement
17. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
18. ASTM C 138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
19. ASTM C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete
20. ASTM C 150 – Standard Specification for Portland Cement
21. ASTM C 157 - Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete
22. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete
23. ASTM C 192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
24. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
25. ASTM C 260 – Standard Specification for Air-Entraining Admixtures for Concrete
26. ASTM C 295 – Standard Guide for Petrographic Examination of Aggregates for Concrete
27. ASTM C 457 – Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete

28. ASTM C 494 – Standard Specification for Chemical Admixtures for Concrete
29. ASTM C 595 – Standard Specification for Blended Hydraulic Cements
30. ASTM C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
31. ASTM C 989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
32. ASTM C 1012 – Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution
33. ASTM C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
34. ASTM C 1157 – Standard Performance Specification for Hydraulic Cement
35. ASTM C 1260 – Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
36. ASTM C 1567 – Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
37. ASTM C 1579 – Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)
38. ASTM C 1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
39. ASTM C 1609 – Standard Test Method for Flexural Performance of Fiber Reinforced Concrete (Using Beam with Third-Point Loading)
40. ASTM C 1778 – Standard Guide for Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  1. Sources of all materials and certifications of compliance with specifications for all materials.
  2. Certified current (less than 6 months old) chemical analysis (mill test report) of the Portland Cement or Blended Cement to be used. The chemical analysis must

include the equivalent alkali content of the Portland Cement or Blended Cement. For Type IL cement, submit updated cement mill test reports every 6 months while active concrete work is being performed.

3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.
4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.
5. Manufacturer's data on all admixtures stating compliance with required standards.
6. Concrete mix design for each class of concrete specified herein.
7. Verification that concrete mix and individual constituents in concrete meet requirements for NSF 61 approval for potable water applications where required.
8. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.
9. Drying shrinkage test results from trial concrete mixes.

#### **1.05 QUALITY ASSURANCE**

- A. Tests on materials used in the production of concrete shall be required as specified in Part 2 – Products. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.
- B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner. Where historical data is utilized for mix design verification, submit certified cement chemical analysis (mill test report) for the historical concrete.
- C. Field quality control tests, as specified in Article 3.11, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field-Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

## **PART 2 – PRODUCTS**

## 2.01 HYDRAULIC CEMENT

### A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.03 or 2.04, respectively.
2. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.
3. Portland Cement shall also meet performance requirements of ASTM C 1157.

### B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement), Type IS (Portland Slag Cement), or Type IL (Portland Limestone Cement) conforming to ASTM C 595.
2. Type IP cement shall be an inter-ground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.
3. Type IS cement shall be an inter-ground blend of Portland Cement and slag cement in which the slag cement constituent is between 30% and 40% of the weight of the total blend.
4. Type IL cement shall be an inter-ground blend of Portland Cement and limestone in which the limestone constituent is between 5% and 15% of the weight of the total blend.
5. Fly ash, slag cement, and limestone used in the production of blended cements shall meet the requirements of Articles 2.03, 2.04, and 2.05 respectively.
6. Cements meeting ASTM C 1157 shall not be used in manufacture of blended cements.
7. Blended cement shall meet the Physical Requirements of Tables 2 and 3 of ASTM C 595 including the requirements for high sulfate resistance in Table 3 as tested per ASTM C1012.

- C. Different types of cement shall not be mixed, nor shall they be used alternately except when authorized in writing by the Engineer. For Type IP, Type IS or Type I/II cement,



different brands of cement or the same brand from different mills may be used alternately. For Type IL cement, use of a different cement brand or same brand from a different mill requires resubmittal of the mix design with current mill test report for review. A resubmittal will be required if different cements are proposed during the Project.

- D. Cement shall be stored in a suitable weather-tight building to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

## **2.02 FLY ASH**

- A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618. Fly ash shall be considered as a supplemental cementitious material.
- B. For fly ash to be used in the production of Type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.
- C. Where reactive aggregates as defined in Article 2.08 are used in the concrete mix, the fly ash constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of fly ash shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where fly ash is used, the minimum fly ash content shall be 15%.
- D. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

## **2.03 SLAG CEMENT**

- A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.
- B. Where reactive aggregates as defined in Article 2.08 are used in concrete mix, the slag cement constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of slag cement shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where Slag Cement is used, the minimum Slag Cement content shall be 30%, and the maximum Slag Cement content shall be 40%.

- C. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- D. Additional slag cement shall not be included in concrete mixed with Type IS or IP cement.

#### **2.04 PORTLAND LIMESTONE CEMENT (TYPE IL)**

- A. Portland Limestone Cement (Type IL) cement shall meet the requirements of ASTM C 595.
- B. Limestone used for blended cement Type IL shall be naturally occurring and meet the requirements of ASTM C 33.
- C. Fly ash or slag cement shall be used with Type IL cement to meet requirements for durability, ASR resistance, sulfate resistance, and use for environmental structures, as specified herein.

#### **2.05 CONCRETE ALKALI LOADING**

- A. All concrete mixes containing potentially reactive aggregates shall have a maximum alkali loading of the concrete of 3.0 pounds per cubic yard.
- B. The alkali loading of concrete is the Portland Cement equivalent alkali content multiplied by the Portland Cement content of the mix in pounds per cubic yard divided by 100. The Portland Cement equivalent alkali content shall be included in the certified chemical analysis of the Portland Cement.
- C. Means of evaluating alkali loading of concrete and proportioning constituents of concrete to minimize alkali loading of content shall also conform to the guidelines of ASTM C1778.

#### **2.06 WATER**

- A. Water used for mixing concrete shall be clear, potable, and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts, and other impurities.
- B. Water shall not contain more than 100 PPM chloride.
- C. Water shall not contain more than 500 PPM dissolved solids.
- D. Water shall have a pH in the range of 4.5 to 8.5.
- E. Water shall meet requirements of ASTM C 1602.

## 2.07 AGGREGATES

- A. All aggregates used in normal weight concrete shall conform to ASTM C 33.
- B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.
- C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel, or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.
- D. For Class A4 and A7 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.
- E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.
- G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology like sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.
  - 1. Non-reactive aggregates shall meet the following requirements:
    - a. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:
      - 1) Optically strained, micro-fractured, or microcrystalline quartz, 5.0%, maximum.
      - 2) Chert or chalcedony, 3.0%, maximum.
      - 3) Tridymite or cristobalite, 1.0%, maximum.
      - 4) Opal, 0.5%, maximum.
      - 5) Natural volcanic glass in volcanic rocks, 3.0%, maximum.
  - 2. Concrete mixed with reactive aggregates shall meet the following requirements:

- a. If aggregates are deemed potentially reactive as per ASTM C1778 and fly ash or slag cement is included in proposed concrete mix design, proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.
  - b. If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.
  - c. If the proposed aggregates are deemed potentially reactive, the concrete mix shall be evaluated and confirmed to meet the requirements for concrete alkali loading as stipulated in Section 2.06.
- H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.
- I. Lightweight aggregate for Class C concrete shall conform to ASTM C330 and shall be Stalite by Carolina Stalite Company or equivalent approved expanded slate produced by the rotary kiln method. Maximum aggregate size shall be 1/2 inch.

## **2.08 SYNTHETIC FIBERS**

- A. Micro-synthetic fibers shall meet requirements of ASTM C 1116 and shall provide a minimum cracking reduction ratio (CRR) of 40 percent when tested in accordance with ASTM C 1579. Acceptable products are MasterFiber F Series or M Series by Master Builders Solutions, or equal. Micro-synthetic fibers shall be included in cement grout mixes where grout topping is to be swept into place by equipment mechanism.
- B. Macro-synthetic fibers shall meet the requirements of ASTM C 1116 and shall have a minimum equivalent flexural strength ratio of 25 percent when tested in accordance with ASTM C 1609. Acceptable products are MasterFiber MAC Series by Master Builders Solutions, Tuf Strand SF by the Euclid Chemical Company, Strux 90/40 by W.R. Grace, or equal.
- C. Fibers shall be used only where specifically required on Contract Drawings or where specifically approved by Engineer.

## **2.09 ADMIXTURES**

- A. Admixtures containing intentionally added chlorides shall not be used.
- B. Admixtures containing 1,4 Dioxane shall not be used in Projects located in a State or Commonwealth where 1,4 Dioxane limits are required.

- C. Air entraining admixture shall be added to all concrete unless noted otherwise. The air entraining admixture shall conform to ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be collected, and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- D. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set, and enhancing durability. Admixtures permitted shall confirm to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.
1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are “Eucon Series” by the Euclid Chemical Company, “Master Pozzoloth Series or Master Polyheed Series” by Master Builders Solutions, and “Plastocrete Series” by Sika Corporation.
  2. High range water reducer shall conform to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at the batch plant and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured, and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day’s operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are “Eucon 37” or Plastol 5000 by the Euclid Chemical Company, “Master Rheobuild 1000 or Master Glenium Series” by Master Builders Solutions, and “Daracem 100 or Advaflo Series” by W.R. Grace.
  3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year’s duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are “MasterSet AC 534 or MasterSet FP 20” by Master Builders Solutions, “Accelguard 80/90 or NCA” by the Euclid Chemical Company and “Daraset” by W.R. Grace.
  4. A retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type B or D. Acceptable products are “Eucon NR or Eucon Retarder 100” by the Euclid Chemical Company, “MasterSet R Series or MasterSet DELVO Series” by Master Builders Solutions, and “Plastiment” by Sika Corporation.
  5. Workability Retaining Admixture shall conform to ASTM C 494, Type S. The admixture shall retain concrete workability without affecting time of setting or early-

age strength development. Acceptable products are “MasterSure Z 60” by Master Builders Solutions, ViscoFlow-2020 by Sika Corporation, PLASTOL AMP-X3 by Euclid Chemical Company, or equal.

- E. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.
- F. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

**2.10 CONCRETE MIX DESIGN**

- A. The proportions of cement, aggregates, admixtures, and water used in the concrete mixes shall be based on laboratory trial mixes in conformance with ACI 301. Trial mixes shall also conform to Article 3.01 of this Specification. Trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.
- B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

1. Compressive Strength (28-Day)

Concrete Class A1, A5	4,500 psi (min.), 6500 psi (max.)
Concrete Class A2, A3, A4	4,000 psi (min.), 6000 psi (max.)
Concrete Class A6, A7	6,000 psi (min.), 8,000 psi (max.)
Concrete Class B	3,000 psi (min.), 5000 psi (max.)

2. Water/cementitious materials ratio, by weight

	Maximum	Minimum
Concrete Class A1, A5	0.42	0.39
Concrete Class A2, A3, A4	0.45	0.39
Concrete A6, A7	0.40	0.35
Concrete Class B	0.50	0.39

3. Slump range

- a. 4" nominal unless high range water reducing admixture is used.
- b. 10" max if high range water reducing admixture is used.

4. Air Content

Concrete Class A1, A2, A4, A5, A6, A7	6% ±1.5%
Concrete Class A3, B	3% Max (non-air-entrained)

C. Lightweight concrete (Class C) shall be composed of cement, lightweight aggregate, sand, synthetic fibers, water, and admixtures, and shall conform to the following requirements:

- 1. Compressive Strength (28-Day) - 4,000 psi (min.), 6,000 psi (max.)
- 2. Minimum Cementitious Materials Content - 550 lb/cy
- 3. Air Content - 6% ±1.5%
- 4. Maximum Slump - 4"-8" after addition of high range water reducer
- 5. Maximum Equilibrium Density - 115 PCF
- 6. Lightweight aggregate shall be presoaked for 48 hours prior to mixing concrete.
- 7. Fiber Content – per manufacturer’s recommendations. Add to wet concrete at batch plant per manufacturer’s requirements.

**PART 3 – EXECUTION**

**3.01 TRIAL MIXES**

A. Trial mixes shall be used to confirm the quality of a proposed concrete mix in accordance with ACI 301. An independent qualified testing laboratory designated and retained by the Contractor shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement, supplementary cementitious materials, and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

- B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and density (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. ". If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

### 3.02 SHRINKAGE TESTS

- A. Concurrent with the trial batch requirements stated in Article 3.01, the testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein. Shrinkage testing is only required for concrete to be used for environmental concrete structures (Class A1).
- B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows.
1. Remove specimens from molds at an age of 23 hours  $\pm$  1 hour after trial batching.
  2. Place specimens immediately in water at 70 °F  $\pm$  3 °F for at least 30 minutes.
  3. Measure within 30 minutes thereafter to determine original length, then submerge in saturated lime water at 73 °F  $\pm$  3 °F.
  4. At age seven days, measure to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).
  5. Store specimens immediately in a humidity-controlled room maintained at 73 °F  $\pm$  3 °F and 50 percent  $\pm$  4 percent relative humidity for the remainder of the test.
  6. Make and report separately measurements to determine shrinkage expressed as base length percentage for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
- C. Compute the drying shrinkage deformation for each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age.



Compute the average drying shrinkage deformation for the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage for any specimen departs from the average test age for that test by more than 0.0004 inch, disregard the results obtained from that specimen. Report results from the shrinkage test to the nearest 0.001 percent of shrinkage. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered part of the normal compression tests for the project.

- D. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.
- E. If the trial batch specimens do not meet both the strength and shrinkage requirements, revise the mix designs and/or materials and retest.

### **3.03 PRODUCTION OF CONCRETE**

- A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready-mix concrete plant or from a site mixed plant. In selecting the source for concrete production, the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.
- B. Ready-Mixed Concrete
  - 1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
  - 2. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
  - 3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
  - 4. Truck mixers and their operation shall 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 one inch when the specified slump is 3 inches or less, or if they differ by 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.

5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed within the time requirements stated in Article 3.04 of this Section.
6. Every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:
  - a. Date and truck number
  - b. Ticket number
  - c. Mix designation of concrete
  - d. Cubic yards of concrete
  - e. Cement brand, type, and weight in pounds
  - f. Weight in pounds of fine aggregate (sand)
  - g. Weight in pounds of coarse aggregate (stone)
  - h. Air entraining agent, brand, and weight in pounds and ounces
  - i. Other admixtures, brand, and weight in pounds and ounces
  - j. Water, in gallons, stored in attached tank
  - k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
  - l. Water, in gallons, used (by truck driver)
  - m. Time of loading
  - n. Time of delivery to job (by truck driver)

7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.
8. 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 quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Site Mixed Concrete shall only be used where specifically approved by the Engineer.
2. Scales for weighing concrete ingredients shall be accurate when in use within  $\pm 0.4$  percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
3. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:
  - a. Cement, fly ash, or slag cement  $\pm 1$  percent
  - b. Water  $\pm 1$  percent
  - c. Aggregates  $\pm 2$  percent
  - d. Admixtures  $\pm 3$  percent
4. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
5. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.
6. Mixers with a rated capacity of one cubic yard or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

7. Except as provided below, batches of one cubic yard or less shall be mixed for not less than one minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
8. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
9. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
10. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.
11. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if recommended by the manufacturer.
12. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
13. Addition of retarding admixtures shall be completed within one minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.
14. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

### **3.04 CONCRETE PLACEMENT**

- A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.
- B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all

debris, water, snow, ice, and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures required.

- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.
- D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.
- E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix meeting all specified requirements.
- F. Concrete shall be conveyed as rapidly as practical to the point of deposit by methods which prevent the separation or loss of the ingredients. The concrete shall be deposited so that additional handling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates unless workability-retaining admixtures are included and approved by the Engineer. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.10 of this Section.
- G. Where concrete is conveyed to position by chutes, a continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.
- H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds.

- I. Placing of concrete shall be regulated so the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet, and enough tremies shall be placed in the form to ensure the concrete remains level.
- K. When placing concrete which will be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.
- L. Concrete shall be placed to thoroughly embed all reinforcement, inserts, and fixtures.
- M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. Concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.
- N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.
- O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. Vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration shall not be continued in any one location to the extent that pools of grout are formed.
- P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall ensure that each layer is placed while the previous layer is soft or plastic, so the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.
- Q. To prevent feathered edges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the

angle between such inclined surface and the exposed concrete surface will be not less than 50°.

- R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and water stops, and/or any proposed deviations from the stated requirements to the Engineer for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to prevent washing of mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

### **3.05 PLACING FLOOR SLABS ON GROUND**

- A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.
- B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing, the temperature shall be raised and maintained above 50° long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, the subgrade shall be dampened with water in advance of concreting, but no free water shall remain standing on the subgrade nor any muddy or soft spots when the concrete is placed.
- D. Thirty-pound felt-paper shall be provided between edges of slabs-on-ground and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.
- E. Contraction joints shall be provided in slabs-on-ground at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03 15 16 – Joints in Concrete.
- F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03 35 00 – Concrete Finishes.

Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

### **3.06 PLACING CONCRETE UNDERWATER (CLASS A5 CONCRETE)**

- A. Placing concrete underwater (tremie concrete) will be permitted only when shown on the Drawings. Concrete deposited under water shall be carefully placed in a compacted mass in final position by means of a tremie, a closed bottom dump bucket or other approved method. Care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. Underwater formwork shall be watertight. The consistency of the concrete shall be regulated to prevent segregation of materials. The method of depositing concrete shall be regulated such that the concrete enters the mass of the previously placed concrete from within, displacing water with a minimum disturbance to the surface of the concrete.
- B. Tremie shall consist of a tube having a diameter of not less than 10 inches and constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported to permit free movement of the discharge and over the entire top surface of the work and shall permit rapid lowering when necessary to choke off or retard the flow. The discharge end shall be sealed, and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the placement has been completed.

### **3.07 PLACING CONCRETE UNDER PRESSURE**

- A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall produce a continuous stream of concrete without air pockets. To obtain the least line resistance, the layout of the pipeline system shall contain minimum bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.
- B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.
- C. No aluminum parts shall be in contact with the concrete during the placing of concrete under pressure.
- D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a material's testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field



conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used during construction, and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.

- E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
- G. The minimum diameter of the hose (conduits) shall be four inches.
- H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.
- I. Concrete samples for quality control in accordance with Article 3.11 will be taken at the placement (discharge) end of the line.

### **3.08 ORDER OF PLACING CONCRETE**

- A. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

### **3.09 CONCRETE WORK IN COLD WEATHER**

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.1.
- B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed these minimum values by more than 20°F, unless otherwise approved by the Engineer.
- C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature greater than 100°F. to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete

accessories shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

### **3.10 CONCRETE WORK IN HOT WEATHER**

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.1.
- B. When air temperatures exceed 85°F., or when extremely dry or high wind conditions exist even at lower temperatures, the Contractor and the Contractor's concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing, and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation, and the Engineer reserves the right to modify the proposed measures consistent with the requirements herein. All necessary materials and equipment shall be in place prior to each placing operation.
- C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.
- D. The temperature of the concrete mix when placed shall not exceed 95°F.
- E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being considered. Stockpiled aggregates shall be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, the ice must be entirely melted prior to addition of the water to the dry mix.
- F. Delivery schedules shall be carefully considered in advance to ensure concrete is placed as soon as practical after mixing. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched, unless workability-retaining admixtures are included and approved by the Engineer.
- G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

### **3.11 QUALITY CONTROL**

- A. Field Testing of Concrete
  - 1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.

2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

#### B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material, or labor costs due to such occurrences.
2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

#### C. Density

1. Samples of freshly mixed concrete shall be tested for density by the materials testing consultant in accordance with ASTM C 138.
2. Density tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

#### D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.
2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

#### E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31, and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement more than five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.
3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy themselves that such information shown is correct.
4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the cylinders made in any four consecutive working days and to protect the specimens from falling over, being jarred, or otherwise disturbed during the period of initial curing. The box shall be erected, furnished, and maintained by the Contractor. The box shall be equipped to provide the moisture conditions and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. The curing box shall be placed in an area free from vibration such as pile driving and traffic of all kinds and such that all cylinders are shielded from direct sunlight and/or radiant heating sources. No concrete requiring testing shall be delivered to the site until the storage curing box has been provided. Cylinders shall remain undisturbed in the curing box until ready for delivery to the testing laboratory, but not less than sixteen hours.
5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of cylinders with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day the curing box contains cylinders. Temperature shall be recorded a minimum of three times a day with one recording at the start of the day and one recording at the end of the day.
6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.
7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

#### F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.
  2. The strength level of concrete will be considered satisfactory if the following conditions are satisfied.
    - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.11).
    - b. No individual compressive strength test result falls below the minimum specified strength by more than 500 psi.
  3. If any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
  4. If condition 3.11.F.2.b is not met, additional tests in accordance with Article 3.11, Paragraph H shall be performed.
  5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:
    - a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
    - b. Maintain or add temporary structural support as required.
    - c. Correct the mix for the next concrete placement operation, if required to remedy the situation.
  6. All concrete which fails to meet the ACI requirements, and these specifications is subject to removal and replacement at no additional cost to the Owner.
- G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.
- H. Additional Tests
1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.
  2. If the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.11, Paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

- a. Three cores shall be taken for each sample in which the strength requirements were not met.
  - b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.
  - c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.
  - d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.
  - e. The diameter of core specimens should be at least 3 times the maximum nominal size of the coarse aggregate used in the concrete but must be at least 2-inches in diameter.
  - f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.
  - g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.
  - h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.
3. If the concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM C 457.

### **3.12 CARE AND REPAIR OF CONCRETE**

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the

established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

- B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.
- D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system unless other means of repair are deemed necessary and approved. All repair work shall be performed at no additional cost to the Owner.
- E. Concrete which fails to meet the strength requirements as outlined in Article 3.11, Paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses, and exposure conditions for the area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

**END OF SECTION**

**SECTION 05 05 23**  
**METAL FASTENING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 13 – Galvanizing

**1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. 2021 International Building Code
  - 2. AC 193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
  - 3. AC 308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
  - 4. ACI 318 – Building Code Requirements for Structural Concrete
  - 5. ACI 355.2 – Qualifications of Post-Installed Mechanical Anchors in Concrete
  - 6. ACI 355.4 – Qualifications of Post-Installed Adhesive Anchors in Concrete
  - 7. AISC – RCSC Specification for Structural Joints Using High Strength Bolts
  - 8. AISC – Code of Standard Practice
  - 9. AWS D1.1 – Structural Welding Code – Steel
  - 10. AWS D1.2 – Structural Welding Code – Aluminum



11. AWS D1.6 – Structural Welding Code – Stainless Steel
12. Aluminum Association – Specifications for Aluminum Structures
13. ASTM A572/A572M-94C – Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
14. ASTM A36 – Standard Specification for Carbon Structural Steel
15. ASTM A489 – Standard Specification for Eyebolts
16. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts
17. ASTM D1785 – Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
18. ASTM E3121 – Standard Test Methods for Field Testing of Anchors in Concrete or Masonry
19. ASTM F436 – Standard Specification for Hardened Steel Washers
20. ASTM F467 – Standard Specification for Nonferrous Nuts for General Use
21. ASTM F593 – Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
22. ASTM F594 – Standard Specification for Stainless Steel Nuts
23. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
24. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimension

#### **1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
  2. Anchor design calculations sealed by a Professional Engineer currently registered in the State of Utah. Only required if design not shown on Contract Drawings.
  3. Manufacturer's installation instructions.
  4. Copy of valid certification for each person who is to perform field welding.

5. Certified weld inspection reports, when required.
6. Welding procedures.
7. Installer qualifications.
8. Certification of Installer Training.
9. Inspection Reports.
10. Results of Anchor Proof Testing.
11. Manufacturer's Literature for Resistance of Adhesive to Appropriate Chemical Exposure, where deemed necessary.

#### **1.05 QUALITY ASSURANCE**

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. Evaluation Report: A current Evaluation Report from an independent testing and evaluation agency (ITEA) shall be submitted for all anchors that will be used on this project. The ITEA producing the evaluation report shall be accredited in accordance with the requirements for ITEA's in ACI 355.2 (mechanical anchors) or 355.4 (adhesive anchors). Acceptable ITEA's include but are not necessarily limited to the International Code Council Evaluation Service (ICC-ES) and the International Association of Plumbing and Mechanical Officials Uniform Evaluation Service (IAPMO-UES).
- C. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installers for anchor installations shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.
- D. Installer Training: For concrete anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:
  1. Hole drilling procedure.
  2. Hole preparation and cleaning technique.
  3. Adhesive injection technique and dispenser training/maintenance.
  4. Concrete adhesive anchor preparation and installation.

5. Proof loading/torquing.
- E. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless-steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.
  - F. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
  - G. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.
  - H. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.
  - I. Inspections of the adhesive dowl system shall be made by the engineer or other representatives of the owner in accordance with the requirements of the ESR pursuant by the manufacturer. Provide adequate time and access for the inspections of products and anchor holes prior to injections, installation, and roof testing.

## **PART 2 – PRODUCTS**

### **2.01 ANCHOR RODS**

- A. Anchor rods shall conform to ASTM F1554 Grade 55 except where stainless steel or other approved anchor rods are shown on the Drawings or stated herein. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A. Washers shall meet the requirements of ASTM A436.
- B. All anchors into concrete shall be cast-in-place anchors unless specifically referenced otherwise on Drawings.
- C. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot dipped galvanized in accordance with ASTM F1554.
- D. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

## 2.02 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM F3125, Grade A325 Type 1 or Grade F1852 Type 1. Bolts, nuts, and washers shall meet the requirements of RCSC “Specification for Structural Joints Using High Strength Bolts”.
- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot dipped galvanized in accordance with ASTM A325.

## 2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593 for alloy groups 1 and 2, Condition CW1, or ASTM F-3125. All fasteners for aluminum and stainless steel members that are underwater, in confined areas containing fluid, and in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts, washers, and lock washers shall be of the same alloy as the bolts.

## 2.04 CONCRETE ANCHORS

- A. General
  - 1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used. Where one of the types listed below is specifically called for on the Drawings, only that type shall be used. If no specific type is indicated on the Drawings, the concrete anchor shall be a cast-in-place anchor. The determination of anchors equivalent to those listed below shall be based on test data performed by an approved independent testing laboratory. Two types of anchors shall be used:
    - a. Mechanical anchors include any of the following anchors:
      - 1) Expansion anchors shall be mechanical anchors of the wedge, sleeve, or drop-in type that are set by expanding against the sides of the drilled hole.
      - 2) Screw anchors are mechanical anchors that derive tensile holding strength by the mechanical interlock provided by threads cutting into the concrete during installation. Screw anchors shall be one-piece, heavy duty screw anchors with a finished head.

- b. Adhesive anchors shall consist of threaded rods anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two-part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.
  2. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the International Building Code and ACI 318 Appendix D requirements as applicable, including seismic test requirements.
  3. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire-resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or be only as anchors for non-structural elements.
  4. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.
- B. Wedge Anchors:
  - a. Do not use when subjected to vibration.
  - b. Do not use in exterior locations or locations subjected to freezing.
  - c. Do not use in submerged, intermittently submerged, or buried locations.
  - d. Suitable for use in overhead applications.
- C. Screw Anchors:
  - a. Do not use when subjected to vibration.
  - b. Do not use in exterior locations or locations subjected to freezing.
  - c. Do not use in submerged, intermittently submerged, or buried locations.
  - d. Suitable for use in overhead applications.
- D. Sleeve Anchors:
  - a. Do not use when subjected to vibration.
  - b. Do not use in exterior locations or locations subjected to freezing.
  - c. Do not use in submerged, intermittently submerged, or buried locations.

d. Suitable for use in overhead applications.

E. Undercut Anchors:

a. Suitable for use where subjected to vibration.

b. Do not use in exterior locations or locations subjected to freezing.

c. Do not use in submerged, intermittently submerged, or buried locations.

d. Suitable for use in overhead applications.

F. Adhesive Anchors in Concrete:

a. Suitable for use where subjected to vibration.

b. Suitable for use in exterior locations or locations subjected to freezing.

c. Suitable for use in submerged, intermittently submerged, or buried locations.

d. Do not use in overhead applications, unless otherwise shown or approved by Engineer.

e. Suitable for use in chemical areas provided manufacturer's literature confirms appropriate chemical resistance.

f. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

G. Adhesive Anchors in Masonry (where cells have been fully grouted)

a. Suitable for use where subjected to vibration.

b. Suitable for use in exterior locations or locations subjected to freezing.

c. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

d. Suitable for use in precast hollow core planks provided cores have been fully grouted.

H. Concrete Anchor Design:

1. Basis of design shall include the following design parameters:

a. Actual compressive strength of concrete.

- b. Cracked concrete conditions.
  - c. Dry or water saturated installation conditions.
  - d. Base material temperature between 40- and 104-degrees Fahrenheit.
  - e. Installation with hammer drill or hollow-drill bit system drilling methods.
  - f. Installation not prior to 21-day minimum age of concrete.
2. An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, the anchors shall be installed to the prescribed size, spacing, embedment depth, and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.
- a. The Contractor shall submit design with sealed calculations and drawings performed by an Engineer currently registered in the State or Commonwealth in which the project is located. Anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.
  - b. Embedment Depth
    - 1) Minimum anchor embedment shall be as indicated on the Drawings unless anchor design is stipulated to be by Contractor or equipment provider. The provider of equipment including pumps, blowers, etc. shall provide anchor design including size of anchors, pattern, and embedment depth. If the equipment provider is unable to provide design of embedment depth, the design shall be provided by the contractor using the loads furnished by the equipment provider. Although all manufacturers listed are permitted, the embedment depth and adhesive type shall be as indicated on the Drawings. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.
    - 2) Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (mechanical anchors) or to provide a minimum allowable

bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).

- 3) The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long-term temperature of 110 degrees F, and maximum short-term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

I. Anchors:

1. Mechanical Anchors:

- a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Power-Stud+SD1" or "Power-Stud+ SD-2" by DeWalt.
- b. Screw Anchors: Screw anchors shall be "KWIK HUS-EZ", "KWIK HUS-EZ-I", or "KWIK HUS-EZ CRC" by Hilti, Inc., "Titen HD" or "Stainless Steel Titen HD" by Simpson Strong-Tie Co., or "Screw-Bolt+" by DeWalt.
- c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by DeWalt.
- d. Shallow Embedment Internally Threaded Insert (3/4" max embedment): "Mini-Undercut +Anchor" by DeWalt, "HDI-P-TZ" by Hilti, Inc. or approved equal.
- e. Concrete Undercut Anchors: Concrete undercut anchors shall be "HDA Undercut Anchors" by Hilti, Inc, "DUC Ductile Undercut Anchor", by USP Structural Connectors, or approved equal.
- f. Mechanical anchor systems shall comply with ACI 355.2 or alternatively the latest revision of AC 193 and shall have a valid evaluation report in accordance with the applicable building code.

2.

Adhesive Anchors:

- a. Adhesive anchors shall be "HIT HY-200 Adhesive Anchoring System" by Hilti, Inc., "SET-3G Epoxy Adhesive Anchors" by Simpson Strong-Tie Co., or "Pure 110+ Epoxy Adhesive Anchor System" by DeWalt.
- b. Adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F)



as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Adhesive anchor systems shall comply with ACI 355.4 or alternatively the latest revision of AC308 and shall have a valid evaluation report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

J. Concrete Anchor Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per anchor manufacturer's recommendations but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be manufactured from stainless steel unless noted otherwise. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
3. Nuts, washers, lock washers and other hardware shall be of a material to match the anchors.

## 2.05 MASONRY ANCHORS

- A. Adhesive anchors for fastening to solid or grout-filled masonry shall be anchors consisting of threaded rods anchored with an adhesive system. The adhesive system shall be "HIT HY-270 System" as manufactured by Hilti, Inc., "AC100+ Acrylic Adhesive" by DeWalt, or "SET-XP" as manufactured by Simpson Strong-Tie Co.
- B. Adhesive anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "HIT HY-270 System" as manufactured by Hilti, Inc., "AC100+ Acrylic Adhesive" by DeWalt, or "SET-XP" as manufactured by Simpson Strong-Tie Co.
- C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

- D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be manufactured from stainless steel unless noted otherwise. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- E. Nuts, washers, lock washers and other hardware shall be of a material to match the anchors.
- F. Although all manufacturers listed are permitted, the masonry anchor design shall be as indicated on drawings. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the proposed product and the Contractor shall provide the conditions stipulated by the Engineer specific to the approved adhesive anchor.
- G. If the masonry cells are fully grouted and the application is not an exterior application where freezing is a concern, a submerged or below grade application, or an application where vibrations could occur, screw anchors may be considered for anchoring items to masonry walls.

## **2.06 WELDS**

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

## **2.07 WELDED STUD CONNECTORS**

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

## **2.08 EYEBOLTS**

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

## **2.09 HASTELLOY FASTENERS**

- A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276. Hastelloy fasteners shall be used for fasteners located in chemical areas containing Hydrochloric Acid (Muriatic Acid), Hydrofluosilicic Acid (Fluoride), or Sulfuric Acid.

## **2.10 TITANIUM FASTENERS**

- A. Titanium fasteners, washers, and nuts shall conform to ASTM B348, Grade 2. Titanium fasteners shall be used for fasteners located in chemical areas containing Ferric Chloride or Sodium Hypochlorite.

## **2.11 ANTISEIZE LUBRICANT**

- A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

# **PART 3 – EXECUTION**

## **3.01 MEASUREMENTS**

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

## **3.02 FASTENER INSTALLATION**

- A. Anchor Rods, Concrete Anchors, and Masonry Anchors
  1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by securing rods where concrete will be placed and positioned by means of a rigidly secured template. Overhead anchors, and base plates or elements being anchored, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
  2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
  3. Post-installed concrete anchors shall not be used in place of cast-in-place anchor rods without Engineer's approval.
  4. All stainless-steel threads shall be coated with anti-seize lubricant.
- B. High Strength Bolts
  1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with RCSC "Specification for Structural Joints Using High Strength Bolts". All bolted joints shall be Type N,

snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

#### C. Stainless Steel Bolts

1. Where connections indicate the use of stainless-steel bolts, the bolts shall be installed to the snug tight condition. Connections shall include stainless steel washers under both the bolt head and the nut head. Lock washers shall be utilized for all connections and shall be placed under the nut head.

#### D. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and ambient temperature at time of installation shall be at least 50 degrees F.
2. Concrete Anchor Testing:
  - a. At all locations, at least 10 percent of all concrete anchors installed shall be proof tested to 80% of the yield strength of the anchor rod, with a minimum of one tested anchor per anchor group.
  - b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E3121 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.
  - c. Where Contract Documents indicate anchor design to be the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. Documentation shall also be submitted indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E3121.
  - d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting

damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.

- e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.
3. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
4. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed, cored holes shall be roughened in accordance with manufacturer requirements. If hammer drills are used to drill holes in slabs, the drills shall be equipped with a depth stop device. The depth of hole shall be the minimum depth required for anchor embedment and development of required capacity. Prior to drilling, the contractor shall use GPR or other means to confirm anchor installation will not interfere with reinforcement or embedded items, especially electrical conduit. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.
5. All adhesive anchor installations shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-11 D.9.2.2. Current AAI Certificate must be submitted to the Engineer of Record prior to commencement of any adhesive anchor installations.

#### E. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be isolated via an approved dielectric.
2. All stainless-steel bolts shall be coated with anti-seize lubricant.

**3.03 WELDING**

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.
- B. Welded stud connectors shall be installed in accordance with AWS D1.1.
- C. Welds shown on the Drawings with a field weld symbol shall be field welded. All other welds shall be shop welded unless specifically approved by the Engineer.

**3.04 INSPECTION**

- A. High strength bolting will be visually inspected in accordance with RCSC "Specification for Structural Joints Using High Strength Bolts". Rejected bolts shall be either replaced or retightened as required.
- B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.
- C. Post-installed concrete anchors shall be inspected as required by ACI 318.

**3.05 CUTTING OF EMBEDDED REBAR**

- A. The Contractor shall not cut embedded rebar cast into concrete during installation of post-installed anchors without prior approval of the Engineer.

**END OF SECTION**

**SECTION 05 10 00**  
**METAL MATERIALS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Metal materials not otherwise specified shall conform to the requirements of this Section.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Materials for fasteners are included in Section 05 05 23 – Metal Fastening.
- B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. ASTM A36 – Standard Specification for Structural Steel
- B. ASTM A47 – Standard Specification for Malleable Iron Castings
- C. ASTM A48 – Standard Specification for Gray Iron Castings
- D. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- E. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- F. ASTM A276 – Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
- G. ASTM A307 – Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- H. ASTM A446 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
- I. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- J. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

- K. ASTM A529 – Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)
- L. ASTM A536 – Standard Specification for Ductile Iron Castings
- M. ASTM A570 – Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- N. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- O. ASTM A992 – Standard Specification for Structural Steel Shapes
- P. ASTM A666 – Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
- Q. ASTM A1085 – Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
- R. ASTM B26 – Standard Specification for Aluminum-Alloy Sand Castings
- S. ASTM B85 – Standard Specification for Aluminum-Alloy Die Castings
- T. ASTM B108 – Standard Specification for Aluminum-Alloy Permanent Mold Castings
- U. ASTM B138 – Standard Specification for Manganese Bronze Rod, Bar, and Shapes
- V. ASTM B209 – Standard Specification for Aluminum-Alloy Sheet and Plate
- W. ASTM B221 – Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- X. ASTM B308 – Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
- Y. ASTM B574 – Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod
- Z. ASTM F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
- AA. ASTM F593 – Standard Specification for Stainless Steel Fasteners

#### **1.04 SUBMITTALS**

- A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.



**1.05 QUALITY ASSURANCE**

- A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials, the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

**PART 2 – PRODUCTS**

**2.01 CARBON AND LOW ALLOY STEEL**

- A. Material types and ASTM designations shall be as listed below:

Steel W, C, and MC Shapes	A992
Steel HP Shapes	A572 Grade 50
Steel M and S shapes and Angles, Bars, and Plates	A36
Rods	F 1554 Grade 55
Pipe - Structural Use	A53 Grade B
Hollow Structural Sections	A500 Grade C or A1085 Grade A
Cold-Formed Steel Framing	A 653

**2.02 STAINLESS STEEL**

- A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.
- B. Material types and ASTM designations are listed below:

Plates and Sheets	ASTM A167 or A666 Grade A
Structural Shapes	ASTM A276
Fasteners (Bolts, etc.)	ASTM F593

**2.03 DISSIMILAR METALS**

A. Dielectric isolation shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			•	•	•	•	•	•	•
Galvanized Steel			•	•	•	•	•	•	•
Aluminum	•	•		•	•	•	•	•	•
Cast Iron	•	•	•				•	•	•
Ductile Iron	•	•	•				•	•	•
Mild Steel/ Carbon Steel	•	•	•				•	•	•
Copper	•	•	•	•	•	•			•
Brass	•	•	•	•	•	•			•
Stainless Steel	•	•	•	•	•	•	•	•	

1. "•" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 05 31 00**  
**METAL DECKING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish all labor, equipment, materials and services to install all metal deck complete with all accessories for a complete installation in accordance with the Drawings and as specified herein.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 13 – Galvanizing
- C. Section 05 05 23 – Metal Fastening

**1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. AISI – Specification for the Design of Cold-Formed Steel Structural Members
- B. SDI – Design Manual for Floor Decks and Roof Decks and Manual of Construction with Steel Deck
- C. ASTM Standards for Test Methods
- D. AWS D1.3 – Structural Welding Code – Sheet Steel
- E. ANSI/SDI SD-2022 – Standard for Steel Deck

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  - 1. Complete layout and installation drawings and schedules with clearly marked dimensions.
  - 2. Detail and location drawings for all framing, supports, type and location of all welds and fasteners.
  - 3. Details of all accessories showing welding washers, studs and reinforcing strips.
  - 4. Manufacturer's design calculations or published literature for the structural properties of the metal decking.

5. Qualifications of welders.

### **1.05 QUALITY ASSURANCE**

- A. All materials, workmanship and production methods shall be in accordance with ANSI/SDI SD-2022 Standard for Steel Deck.
- B. Manufacturer shall be regularly engaged in the manufacture of metal decking.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. Steel sheet shall be flat rolled carbon steel sheets meeting the requirements of ASTM A653 Grade 80 for galvanized metal deck or ASTM A1008 Grades 80 for bare metal deck.
- B. Minimum yield strength shall be 50 ksi.
- C. Unless noted otherwise, metal deck shall be galvanized in accordance with Section 05 05 13 – Galvanizing.
- D. Mechanical fasteners used for sidelap connections shall be SDI standard.

## **PART 3 – EXECUTION**

### **3.01 FABRICATION AND DESIGN**

- A. Design, fabrication and erection of decking shall comply with references listed in Section 1.03 and manufacturer's recommendations.
- B. Deck units shall conform to the SDI standard type and gage shown on the Drawings.

### **3.02 DELIVERY, STORAGE, AND HANDLING**

- A. Materials shall be delivered in unbroken, undamaged, original packages bearing manufacturer's labels.
- B. Metal decking shall be stored off the ground with one end elevated for drainage and covered with vented water-proof material in accordance with decking manufacturer's recommendations.
- C. Decking shall be handled so as to preclude damage from any source.
- D. Metal decking units may not be used for any purpose (such as scaffold decking) prior to incorporation in the work. Any units which have been so used will be rejected.

**3.03 INSPECTION**

- A. Verify correct layout and alignment of supporting members and clean all support surfaces of debris. All defects shall be corrected prior to installation of metal decking.

**3.04 INSTALLATION**

- A. Install deck units and accessories in accordance with shop drawings and manufacturer's recommendations. Deck units shall be installed where called for on the Drawings.
- B. Position deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened. Extend deck units over three or more supports unless shown otherwise on the Drawings. Lap ends not less than 2 inches. Place deck units flat and square, secured to adjacent framing without warp or deflection.
- C. Secure deck units to supporting members as shown on the Drawings. Weld pattern shall be as indicated on the Drawings in accordance with SDI and AWS D1.3. The Contractor may use an equivalent pattern of mechanical fasteners in lieu of welded fastening.
- D. Attach deck at sidelaps with screws as indicated on the Drawings or as recommended by the manufacturer.
- E. Cut and fit deck units around openings. Deck manufacturer shall approve openings larger than 6" diameter prior to cutting.

**3.05 REPAIR OF GALVANIZING**

- A. Galvanizing shall be repaired at all welds, scarred areas, and rust spots in accordance with Section 05 05 13 – Galvanizing.

**3.06 CONSTRUCTION GUIDELINES**

- A. Do not use deck units as a working platform or storage area until units are permanently attached in position.
- B. Construction loads shall not exceed the load carrying capacity of the deck.
- C. All units damaged during construction shall be repaired or replaced by the Contractor.

**END OF SECTION**

**SECTION 05 50 00**  
**METAL FABRICATIONS**

**PART 1 – GENERAL**

**1.01 REQUIREMENT**

- A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 23 – Metal Fastening
- C. Section 05 05 13 – Galvanizing
- D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. 2021 International Building Code
  - 2. AISC – Specification for Structural Steel Buildings
  - 3. AISI – Specifications for the Design of Cold-Formed Steel Structural Members
  - 4. Aluminum Association Specifications for Aluminum Structures

**1.04 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
  - 1. Complete fabrication and erection drawings of all metalwork specified herein.
  - 2. Other submittals as required in accordance with Section 05 10 00 – Metal Materials and Section 05 05 23 – Metal Fastening.

## **PART 2 – PRODUCTS**

### **2.01 METAL MATERIALS**

- A. Metal materials used in metal fabrications shall conform to Section 05 10 00 – Metal Materials, unless noted otherwise.

### **2.02 METAL FASTENING**

- A. All welds and fasteners used in metal fabrication shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

## **PART 3 – EXECUTION**

### **3.01 FABRICATION**

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05 05 23 – Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in Section 09 90 00 – Painting.

### **3.02 INSTALLATION**

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.
- C. Metal work shall be field painted when as specified in accordance with Section 09 90 00 – Painting.

**END OF SECTION**



**SECTION 06 10 00**  
**ROUGH CARPENTRY**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on the Drawings and specified herein.
- B. Principal items of work include:
  - 1. Wood blocking, nailers, grounds, furring, ties, centering, etc., necessary or required for attachment or support of work under this Section and other Sections.
  - 2. Fasteners, including nails, screws, bolts, anchors and other fastenings, required to secure work under this Section.
  - 3. Temporary enclosures and protective boarding.
  - 4. Wood preservative treatment for all wood members in contact with roofing, masonry, concrete, and exposed to the elements.

**1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1. AWPA-CA – Preservative Standards, Lumber and Plywood
  - 2. AWPA-C20 – Structural Lumber Fire-Retardant Treatment by Pressure Process
  - 3. AWPC-C27 – Plywood Fire-Retardant Treatment by Pressure Process
  - 4. AWPA-M4 – Standards for Care of Preservative Treated Wood Products
  - 5. APA – Guide to Plywood Grades
  - 6. FM 1-49 – Perimeter Flashing

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:

1. Certifications of Preservative and Fire Retardant Treatment.
2. Warranty of treatment manufacturer.
3. Certification of type and grade of lumber to be used.
4. Certification of type, rating and conformance to APA Standards.

#### **1.04 DELIVERY AND STORAGE**

- A. Take all measures necessary to protect products against damage during delivery and storage.
- B. Store lumber in enclosed places in such a manner to provide ventilation and protection from the weather.

### **PART 2 – PRODUCTS**

#### **2.01 MATERIALS**

- A. Blocking, nailers, grounds and the like: Eastern Spruce or Douglas Fir - No. 3 Dimension Lumber or Construction Grade, with a moisture content not to exceed 19%.
- B. Plates, blocking, and nailers in contact with concrete or masonry: Pressure treated southern yellow pine or Douglas Fir.
- C. Plywood: Identified with APA Grade trademarks of the American Plywood Association, in thickness as shown on the Drawings.
  1. Exterior: AC-EXT-APA where exposed to view or a finish is required, CD-EXT-APA where concealed.
  2. Interior: AC-INT-APA where exposed to view or a finish is required, CD-INT-APA where concealed.
- D. Structural Framing Lumber: Douglas Fir No.1 grade with fb = 1,500 pounds per square inch and E = 1,700,000 pounds per square inch, 19 percent moisture content.
- E. Fasteners: Provide clamps, connectors, straps, nails, bolts, screws, anchors, ties and other accessories and fasteners shown or required to properly secure all rough carpentry. Fasteners and accessories shall be stainless steel, galvanized, or other noncorrosive metal recommended for use. Fasteners used with pressure treated wood shall be compatible with the wood preservative treatment to prevent corrosion of fasteners.

- F. Wood Preservative Treatment: Waterborne pressure treatment in conformance with the American Wood Preservers' Association standard P5. Retention shall be in accordance with AWWA Standards and be a minimum of 0.40 pounds per cubic foot for contact with or below ground, concrete, or masonry and 0.25 pounds per cubic foot for above ground. Stamp each piece of treated wood with a trademark identifying the classification of the treatment or a certificate from the processor for each shipment.
- G. Fire Retardant Treatment: Fire-retardant lumber and plywood must have an Underwriters Laboratories stamp signifying a FR-S rating and certifying a 25 or less flame spread and smoke developed value, when tested in accordance to UL 723, ASTM E 84, and NFPA 255 "Tunnel Test", and when the test is extended for 20 additional minutes. Treatment formulation shall contain no halogens, sulfates, chlorides or ammonium phosphate. Smoke toxicity shall be no more than that of untreated wood.

### **PART 3 – EXECUTION**

#### **3.01 COORDINATION**

- A. Coordinate with all trades as to nailers, blocking, grounds and the like required for the attachment of their work and other items requiring same. Carry out all work as required to cooperate work of other trades.

#### **3.02 INSTALLATION**

- A. Perform work in conformance manufacturer's recommendations and specifications, industry, national and local standards and codes.
- B. Layout, cut, fit and erect rough blocking, nailers, furring and other rough carpentry. Do cutting work in connection with carpentry and finish for other trades. Brace plumb and level all members in true alignment and rigidly secure in place with sufficient nails, spikes, screws and bolts. Defects which render any piece or part unable to serve its intended purpose shall be discarded or, cut out and replaced.
- C. Provide all bracing, supports and shoring required to support construction.
- D. Protect all masonry including edges of concrete platforms and similar items. Remove protective covering when directed. Take special precautions at masonry openings and corners of the building.
- E. Set all rough hardware, such as plates, spikes, bolts, nails, lag screws, lagging bolts, anchors, etc., as required to hold woodwork together or to anchor or secure it to other materials and construction.
- F. Provide wood grounds, nailing strips and similar items wherever necessary or required throughout the project for the support, proper erection or installation of the work and

support of mirrors, cabinets, shelf cleats, base and similar items. Thoroughly secure in place by approved means.

- G. Secure wood grounds, nailing strips and similar items to metal plugs set in masonry, toggle or expansion bolts. Give the mason all necessary information to enable them to lay out correctly the location for metal wall plugs. Wood plugs will not be accepted.
- H. Construct joints to support dead loads, live loads, snow loads, wind loads, or combinations in conformance with "National Design Specifications for Stress Grade Lumber and its Fastenings", recommended by National Forest Products Association.
- I. Nailers and Blocking: Provide and secure wood nailers, blocking, for the reception of roof curbs, roofing, etc. in accordance with FM I-49, or as required by the Building Code, whichever is most stringent. Coordinate attachment with roofing system, where roofing system design includes design of nailers provide attachment in accordance with engineered roofing design.
  - 1. Provide nailers of sizes, shapes and profiles indicated on the Drawings. Nailers shall not be less than 2 x6. Build up nailers as required to achieve thickness of insulation or as required to provide proper attachment of roofing and curbs. Provide anchors as required for secure attachment of roofing systems, copings, gravel stops or other edge terminations.

### **3.03 TEMPORARY PROTECTION**

- A. Provide and install all temporary protection in accordance with applicable provisions of the Contract Documents, OSHA regulations, and as follows:
  - 1. Temporary protection shall include wood doors, railings, protection of floor or roof openings, temporary partitions, and the like; adequately maintained in good repair during the life of the Contract.
  - 2. Furnish and set temporary partitions with wood doors at all exterior doorways, exterior openings or in locations exposed to weather. Substantially build and hang, with proper hinges, locks and other necessary hardware, and remove and reset whenever required to accommodate the Work and keep in good repair.
  - 3. Provide substantial temporary wood covering or guards for openings left in floor or roof slabs for ducts, shafts, etc., using rough planking at least 2 inch thick, cleated together and otherwise made sufficiently strong and put in place wherever required immediately after the forms have been removed.

### **3.04 JOB CONDITIONS**

- A. If the installation of metal frames and glass does not promptly follow the completion of the exterior enclosures, and if the absence of enclosures would cause damage, close in

all such openings temporarily by the use of heavy polyethylene plastic sheeting, or canvas stretched over and nailed to frames of 1 inch x 2 inch or heavier strips.

**3.05 REMOVAL OF TEMPORARY WORK**

- A. Remove all temporary protection when so directed, or prior to acceptance of this project.

**END OF SECTION**

**SECTION 07 53 23  
SINGLE PLY MEMBRANE ROOFING (EPDM)**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
  - 1. Preparation of roof deck to receive new roofing materials.
  - 2. Application of insulation, and accessories.
  - 3. Fifteen year "Total Roofing System Warranty".
  - 4. Ballast.
  - 5. Removal and cleanup of excess materials and debris.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01 33 00 – Submittal Procedures
- B. Section 06 10 00 – Rough Carpentry
- C. Section 07 60 00 – Flashing and Sheet Metal
- D. Section 07 70 00 – Roof Specialties and Accessories

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. ASTM Designations; Stipulated under PRODUCTS.

**1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures submit the following:
  - 1. Manufacturer's Data.
  - 2. Manufacturer's Installation Instructions.
  - 3. Total System Warranty.

**1.05 QUALITY ASSURANCE**

- A. The installer must be skilled and experienced and approved by roofing membrane manufacturer for type of roofing and associated work required and equipped to perform workmanship in accordance with recognized standards.
- B. Provide periodic inspections by an official manufacturer's technical representative on all roofing and flashing. Inspections to be made at the beginning of the job and a minimum of one more while the roofing and/or flashing work is in progress to insure workmanship is in accordance with the manufacturer's specifications.

**1.06 GUARANTEE**

- A. Furnish to the Owner a fifteen (15) year written Manufacturer's Warranty covering materials and workmanship for the entire "Roofing System", including repair and replacement of roofing components which are deemed faulty or in disrepair during the guarantee period. Such items in disrepair shall be repaired at no cost to the Owner. Cover both labor and materials necessary to effect watertightness, including that required to repair roof leaks caused by standing water, defective material or workmanship, without limit as to amount required to effect watertightness.
- B. Guarantee Label:
  - 1. Furnish a guarantee label to be mounted by the Contractor at the building or other prominent location as directed by the Owner.
  - 2. This label (8-1/2 inch x 11 inch minimum size) shall be laminated in transparent closure for permanent protection. Chart shall be framed in suitable aluminum frame with clear glass front and secured where directed.
  - 3. Label shall contain the following information:
    - a. Type of system.
    - b. Name and address of manufacturer.
    - c. Name, address and phone number of manufacturer's local representative.
    - d. Name, address and phone number of contractor.
    - e. Statement of the warranty and its effective date.
    - f. Cautions and warnings against specific actions or types of misuse which will affect the guarantee.

**1.07 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials in manufacturer's unopened containers identified with name, type, grade, class and all other qualifying information, including UL and other specified insurance agency's labels.
- B. Store materials in a dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have once been wet or damaged and remove from the job site.

**PART 2 – PRODUCTS**

**2.01 ACCEPTABLE MANUFACTURERS, OR EQUAL**

- A. Carlisle Syn Technical Systems Corporation or equal.
- B. Firestone Building Products Company.

**2.02 MATERIALS**

- A. Membrane shall be 0.060-inch thick EPDM. The membrane conforms to the minimum physical properties which meet ASTM D3253.

**EPDM Membrane**

<b>Property</b>	<b>Test Method</b>	<b>Specification</b>
Tolerance on Nominal Thickness percent	ASTM D412	±10
Elongation, Ultimate Min., percent	ASTM D412	300% Min.
Tear resistance, lbf/in	ASTM D412	175 Min.
Brittleness point, max., degrees Fahrenheit (degrees F)	ASTM D746	-49°F
Resistance to heat aging Properties after 4 weeks at 240 degrees Fahrenheit	ASTM D1204	
Breaking Strength Min., lbF (N)		1,200 psi
Elongation, Ultimate Min., percent		200
Linear Dimensional Change Max., percent		±2
Ozone Resistance* Condition after exposure to 100 phm	ASTM D1149	No cracks
Ozone in air for 168 h at 104 degrees Fahrenheit		No cracks

- B. Fasteners:

- 1. General:



- a. The pullout values listed below are considered minimum and have been established to reflect the structural soundness of the deck to provide proper membrane and/or insulation attachment. They are not intended to address additional design loads for the roofing system.
  - b. Fasteners shall be properly coated to resist corrosion and deterioration from the effect of the item being fastened, the substrate or adjacent materials including but not limited to moisture and treatment products.
  - c. Manufacturers Factory Mutual approved concrete fasteners shall be used. Fasteners shall penetrate the deck a minimum of 2 inches to a maximum of 2 1/2 inches. A pilot hole shall be predrilled to a sufficient depth to prevent contact between the fastener point and any accumulated dust in the predrilled hole.
  - d. A minimum pullout value of 800 pounds must be provided.
- C. Flashing: EPDM flashing, furnished by the membrane manufacturer for this system.
- D. Bonding Adhesive: Bonding adhesive, furnished by the membrane manufacturer for this system.
- E. Splicing Cement: Splicing cement, furnished by the membrane manufacturer for this system.
- F. Splice Cleaner and Splice Wipes: Furnished by the membrane manufacturer for this system.
- G. Lap Sealant: Shall be trowel or gun consistency. Furnished by the membrane manufacturer for this system.
- H. In Seam Sealant: Special sealant applied in the splice. Furnished by the membrane manufacturer for this system.
- I. Water Cut-Off Mastic: Furnished by the membrane manufacturer for this system.
- J. Molded pipe Flashing: Furnished by the membrane manufacturer for this system.
- K. Nite Seal and Lay Flat Tubing: Furnished by the membrane manufacturer for this system.
- L. Pourable Sealer: Furnished by the membrane manufacturer for this system.
- M. Rubber Fastening Strip: Furnished by the membrane manufacturer for this system.
- N. Seam Fastening Plates: Two inch diameter metal fastening plates, furnished by the membrane manufacturer for this system.

- O. Edging: Metal or hard rubber material, furnished by the membrane manufacturer for this system.
- P. Walkway system shall be trowel smooth concrete pavers, providing four-way drainage. Pavers shall weigh minimum 15 lbs per square feet and a minimum size of 24 x 24 inches. Install paver ballast over manufacturer's protection materials. Install walkways around all roof mounted equipment.
- Q. Ballast: Smooth water worn gravel with rounded edges and corners. Ballast shall be designed by roofing manufacturer in accordance with ANSI/SP R1 RP-4 – Wind Design Standard for Ballasted Single-Ply Roofing Systems.

## **PART 3 – EXECUTION**

### **3.01 SURFACE PREPARATION**

- A. Contractor shall be responsible for providing proper substrate to receive the roofing system. Installer shall notify Contractor, in writing, of defects in the substrate, and work shall not proceed until defects have been corrected. The starting of work implies the acceptance of such surfaces.
- B. Construction work on the roof shall be complete before the roofing operations commence. The roof surfaces shall be clean, smooth, dry, and free from loose and foreign materials, dirt, oil, grease, and holes.
- C. Surface joints (including walls and substrate) shall be 1/4-inch or less in width. Repair all joints wider than 1/4-inch with approved joint filler before proceeding with installation.
- D. Vents and all other projections through the roof shall be secured in position before roofing is commenced.

### **3.02 INSTALLATION**

- A. Roofing shall be furnished and installed in compliance with U.L. Class "A" requirements. Manufacturer's instructions for the installation of such roofing system shall be strictly adhered to. All accessories necessary to complete the installation shall be provided.
- B. The roofing shall be applied and finished in one area in a continuous operation. Care shall be taken to ensure that water does not flow beneath any completed sections of roof. Loose edges of membrane shall be temporarily sealed with an approved night seal when the weather is threatening. When work is resumed, the sheet shall be pulled free before continuing installation.
- C. Roofing and flashing installation at the junction of all parapet walls, curbs, and other roof openings shall be in accordance with the roof membrane manufacturer's standard details

unless shown otherwise on the Drawings. Typical details of all actual roof conditions shall be submitted for approval prior to membrane installation.

- D. Where required by the Drawings or approved Drawings, wooden nailers shall be installed at the perimeter of the roof and around all vents, skylights, hatches and similar penetrations.
- E. The EPDM roofing membrane shall be placed over the approved substrate without stretching. The membrane shall be allowed to relax approximately one half hour prior to splicing and flashing. Adjoining sheets shall be positioned in the same manner, lapping edges a minimum of 3-inches.
- F. The roofing membrane shall be mechanically fastened at the roof perimeter and around the penetrations according to the manufacturer's directions. All splices shall be made with a minimum lap of 3-inches, using splicing cement, gum tape and lap sealant as directed by the manufacturer.
- G. Perimeter flashing and flashing around vents, skylights, etc., shall be done with manufacturer's standard flashing using the longest pieces practicable. The splice between the flashing and the main roof sheet should be completed before bonding the flashing to the vertical surface. This splice must be sealed at least 3-inches beyond the fasteners which attach the horizontal membrane to the nailer.
- H. Flash all projections (pipes, conduits, etc.) passing through the membrane. Prefabricated pipe seals shall be used to flash all pipes. All flashings and terminations shall be done in accordance with the manufacturer's approved details.

### **3.03 QUALITY CONTROL**

- A. Prior to the placement of the ballast, an inspection shall be made by a representative of the manufacturer in order to ascertain that the roofing system has been installed properly.

**END OF SECTION**

**SECTION 07 60 00  
FLASHING AND SHEET METAL**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 07 53 23 – Single Ply Membrane Roofing
- B. Section 07 70 00 – Roof Specialties and Accessories
- C. Section 07 90 00 – Joint Fillers, Sealants and Caulking

**1.03 REFERENCES SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1. OF-506C – Flux, Soldering, Paste, and Liquid
  - 2. ASTM A176 – Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip
  - 3. ASTM B32 – Specifications for Solder Metal
  - 4. ASTM D1187 – Test Method for Asphalt-Base Emulsions for use as Protective Coatings for Metal
  - 5. "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association.
  - 6. FM Global Data Sheet 1-49, Perimeter Flashing

**1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
  - 1. Manufacturer's literature and installation instructions.

2. Complete layout and installation Drawings and schedules with clearly indicated dimensions.
3. Provide drawings of proposed flashing.
4. Color samples.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials in a clean dry protected area in such manner to preclude damage by denting, warping, or other distortion.

## **PART 2 – MATERIALS**

### **2.01 MATERIALS**

- A. Metal Flashing
  1. Exposed to View: Provide prefinished 0.050 inches aluminum. Provide a full-strength Kynar 500 baked-on paint finish with a 20 year warranty.
  2. Concealed from View: Provide a minimum of 22 ga. galvanized. steel sheet, stainless steel sheet, or mill-finished aluminum sheet.
- B. Nails, screws, rivets, bolts and other fasteners: same material as sheet metal being attached. Nails shall be 18 gauge diameter shank, 1/4 inch diameter flat head, annular-thread, diamond point, long enough to penetrate backing by at least 1 inch. Nails shall be spaced 3 inches on center unless other spacing is indicated. Exposed fasteners shall match finish of metal being fastened.
- C. Reglets shall be formed of 300 series stainless steel, minimum of 0.020 inch. Reglets shall be Model CO for insertion in concrete, MA-4 for insertion in masonry as manufactured by FRY Reglet Corporation. Corners shall be factory made, mitered and sealed. Furnish reglets to proper trade in sufficient time to be incorporated into the masonry or concrete work.
- D. Bituminous plastic cement shall conform to ASTM D4586.
- E. Sealants shall be silicone type or as recommended for specific application.
- F. Sealer tape shall be polyisobutylene tape specifically manufactured for setting flanges on bituminous roofing or as recommended by roofing manufacturer.

**PART 3 – EXECUTION****3.01 FABRICATION**

- A. Shop fabricate Work to greatest extent possible. Comply with details shown and applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry standards. Fabricate for waterproof and weather resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, and damage or deterioration of the work. Comply with material manufacturer's instructions and recommendations for forming material. Form exposed work without excessive oil-canning, buckling and tool marks, true to line and levels as indicated, with exposed edges folded back to form hems.
- B. Roof penetration sheet metal work shall be provided and coordinated with the roofing system. The design and details shall conform to SMACNA "Architectural Sheet Metal Manual". Sheet metal items shall be built into roofing in strict accordance with the instructions of the roofing manufacturer.
- C. Perimeter flashing related to roof systems shall be installed in accordance with FM 1-49 requirements.

**END OF SECTION**

**SECTION 07 61 13**  
**STANDING SEAM METAL ROOFING AND WALL PANELS**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for complete execution of work shown on Drawings and specified herein.
- B. Work includes:
  - 1. Standing seam metal roofing, wall panels, trim, flashing and accessories associated with a complete and weathertight roofing system and as indicated on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 07 21 00 – Building Insulation
- B. Section 07 60 00 – Flashing and Sheet Metal
- C. Section 07 70 00 – Roof Specialties and Accessories
- D.
- E. Section 07 90 00 – Joint Fillers, Sealants and Caulking

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
  - 1. Drawings of proposed work, including fastener type and spacing, roof panels, support framing, flashing, snow retention system, and accessory details. Details shall be drawn to show the entire assembly including all accessories required for complete installation.
  - 2. Manufacturer's product data, specifications and installation instructions.
  - 3. Submit calculations signed by a professional engineer indicating loads, uplifts, spacing of clips, fasteners, snow retention system, and accessories. Calculations shall be project specific in accordance with ASCE 7.
  - 4. Submit certification that installer is authorized by manufacturer.

5. Structural design data and calculations.
6. Drawing showing spacing of fasteners and supports.
7. Letter verifying that panels are factory roll formed.
8. Sample warranties.
9. Copy of 20-year Manufacturer's warranty.

#### **1.04 DESIGN CRITERIA**

- A. Use the following standards and criteria where applicable in the structural design of the roof support system:
  1. Current Building Code of the State or Commonwealth in which the project is located.
  2. "Steel Construction Manual", American Institute of Steel Construction
  3. "Cold Formed Steel Design Manual", American Iron and Steel Institute
  4. ASCE 7 – Minimum Design Loads for Buildings and Other Structures
- B. Design Loads
  1. Design loads include live, snow, wind, earthquake and dead loads.
  2. Loads and combination of loads shall be as prescribed and recommended in the standards and codes listed above.
  3. Design roof to withstand structural information provided on Structural Drawings and in accordance with building code and any local regulations.
  4. Thermal expansion and contraction expected for this location.
- C. FM Global Property Loss Prevention Data Sheets
  1. FM Global Data Sheet 1-28, Wind Design
  2. FM Global Data Sheet 1-29, Roof Deck Securement and Above Deck roof Components
  3. FM Global Data Sheet 1-49, Perimeter Flashing



**1.05 WARRANTY****A. Roof and Wall Panels**

1. Exterior finish shall be warranted by the manufacturer for twenty years against blistering, peeling, cracking, flaking, checking and chipping.
2. Color change and chalking shall be warranted for twenty years. Color change shall not exceed 5 NBS units per ASTM D 224. Chalking shall be not less than a rating of 8 per ASTM D 4214.

**B. Weathertightness**

1. Single Source manufacturer's roof system warranty including roof panels, fascia, trim flashing, penetrations, and other materials integral to the roof system, against leaks for a period of twenty years.
  - a. The warranty shall cover wind damage up to 90 mph.
  - b. No dollar limit.

- C. Provide all materials required by roofing manufacturer to obtain specified warranty whether or not specifically indicated.

**1.06 QUALITY ASSURANCE**

- A. Manufacturer shall have been regularly engaged in the fabrication of metal standing seam roof systems for at least ten years.
- B. Installer shall be authorized by the Manufacturer as trained and qualified to erect the Manufacturer's product.
- C. Conduct a prerooting conference with the following attendees; Contractor, metal-roofing Contractor, metal roofing systems manufacturer's representative, all sub-Contractors whose work penetrates the roof, the Owner and Engineer.
- D. Metal roofing system manufacturer's representative will observe the installation of the roof system at the start of the project and as required by the manufacturer to ensure warranty provisions are adhered to. The manufacturer's representative will produce a report based on observations of the roofing system that indicates that the roofing system, trim, accessories have been installed in accordance with all requirements of the manufacturer. If any deficiencies in materials or installation are found during this inspection the deficiencies shall be corrected.
- E. System shall be tested in accordance with UL 580 or ASTM E 1592.

## **PART 2 – PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Specifications provide products from one of the following:
1. IMETCO, Series 300
  2. Centria, SRS 3
  3. The Garland Company, R MER SPAN

### **2.02 PRODUCTS**

- A. Standing Seam Roof Panels
1. Factory finished 0.040 Aluminum sheets factory finished with two coat, baked-on full-strength (70% resin) fluorocarbon coating system. Color shall be selected by the Owner.
  2. Panels shall be 16” or 18” wide by length required to cover roof to minimize end laps. Panels shall include striated profile or pencil ribs to minimize oil-canning.
- B. Roof System
1. Structural standing seam incorporating with continuous “T” batten and secured to concealed anchor clips allowing unlimited thermal movement, and of configurations that will prevent entrance or passage of water.
  2. Roof system shall comply with UL90 classification.
  3. Fastening system shall allow the roof covering to move independently of any differential thermal movement by the framing system.
  4. Provide interlocking batten cap with a plant applied, and non-hardening sealant. Mechanically lock or crimp seams during installation.
  5. Seal panel termination and perimeter flashing with sealant approved by manufacturer.
  6. Provide metal closures matching roof profile at ridge, headwall, rake, jamb and hip conditions.
  7. Panels length shall be full length from factory. Field formed panels will not be allowed.

8. Coordinate structural support locations for wall and roof panels. Provide additional structural support, if required by panel manufacturer to resist required design loads.
9. Roof and wall panels shall be furnished in continuous lengths from ridge to eave of top of wall to bottom of wall panel.
10. Seam height will be a minimum of 2-3/8".

#### C. Trim System

1. Design trim to provide for expected movement of roof panels due to thermal expansion.
2. Use manufacturer's standard trim pieces, except where field formed pieces are recommended by the manufacturer.
3. Use .032 or .040 Aluminum trim with factory finish to match roof panels.
4. Concealed fasteners shall be used to the greatest extent possible. Where exposed fasteners are used, they shall be installed neatly and aligned with other fasteners in straight rows and lines and finished to match roof panels.

#### D. Roof Accessories

1. Use EPDM roof jacks with aluminum sealing ring for openings 12 inches in diameter or less. Do not use roof jacks where ribs are altered.
2. Provide .032 or .040 gutters and downspouts with a 20-year factory applied fluorocarbon finish. Color shall match roof panels.
3. Snow Retention System: Provide clamps with stainless steel fasteners that mechanically attach to standing seams without penetrating the roof system. Snow retention system shall include cross members to retain snow with snow and ice clips. Snow retention system shall be specifically manufactured for profile of standing seam metal roofing. Snow retention system manufacturer shall design system for local conditions and provide multiple rows as required by the manufacturer's design to resist sliding snow. Snow retention system shall be approved for use by standing seam roofing system manufacturer and not void or limit warranty. Color to match standing seam roofing system and color warranty. Provide S-5 Colorguard by Metal Roof Innovations, Ltd., or SnoBar/ColorBar by SnoBlox-Snojax; or approved equal.
4. Underlayment: Provide underlayment over entire roof area. Underlayment shall be 40 mil self-adhesive membrane. Underlayment may not be shown on drawings.

E. Fascia and Soffit Panels

1. Shall be interlocking flush panels with concealed fasteners. Panels shall be nominal 12" wide by 1" deep and of lengths required to complete work. Finish to match roof panels with 20-year warranty.

**PART 3 – EXECUTION**

**3.01 INSPECTION**

- A. Manufacturer shall inspect conditions of structural system and work below. Verify that work is complete to a point where this work can commence and installation can be performed in accordance with the manufacturer's recommendations and instructions.

**3.02 INSTALLATION**

- A. Install components in accordance with manufacturer's instructions and approved shop drawings.
- B. Replace damaged or defective items.

**END OF SECTION**

**SECTION 07 70 00**  
**ROOF SPECIALTIES AND ACCESSORIES**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work shown on Drawings and specified herein.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 06 10 00 – Rough Carpentry
- B. Section 07 61 13 – Standing Seam Metal Roofing and Wall Panels
- C. Section 07 60 00 – Flashing and Sheet Metal
- D. Section 07 90 00 – Joint Fillers, Sealants and Caulking

**1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1. TT-P-641 (1) – Primer Coating, Zinc Dust - Zinc Oxide (for galvanized surfaces)
  - 2. ASTM A 525 – Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process
  - 3. ASTM A 526 – Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
  - 4. ASTM B 209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - 5. Sheet Metal and Air Conditioning Contractors National Association "Architectural Sheet Metal Manual" (ASMM)
  - 6. The Aluminum Association "Specification for Aluminum Sheet Metal Work in Building Construction."
  - 7. American Welding Society (AWS).
  - 8. FM Global Data Sheet 1-28 Wind Design
  - 9. FM Global Data Sheet 1-49 Perimeter Flashing

**1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
  - 1. Manufacturers literature and installation instructions.
  - 2. Samples, of each material listed.
  - 3. Provide shop drawings for the full extent of each item to be provided. Provide overall plans and details of each transition. Provide details of each item.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver all materials in factory packed unopened cartons and crating bearing the manufacturer's labels.
- B. Store materials in clean, dry protected area in such manner to preclude damage of any nature.
- C. Handle all materials with proper care to avoid denting, marring, warping or other distortions during delivery, storage and handling.

**PART 2 – PRODUCTS****2.01 MATERIALS**

- A. General: Provide roof specialties and accessories of design and construction compatible and approved for use with roofing manufacturer.
- B. Fasteners: Provide all fasteners and attachments required to secure item to substrate and support loads required by applicable Building Code. Use only non-corrosive fasteners which are compatible with materials being joined.
- C. Colors: Colors shall be selected by Owner.

**2.02 GUTTERS AND DOWNSPOUTS**

- A. Material: 0.040 inch aluminum.
- B. Design: Manufacture gutters tapered and notched to provide telescoping joint. Design gutters and downspouts to accommodate expected thermal movement.
- C. Supports and Fasteners: Provide manufacturers' standard straps, brackets and fasteners. Place supports and fasteners at 36 inches on center or as recommended by the manufacturer. Finish of supports, brackets and fasteners shall match gutter and downspout.

- D. Accessories: Provide end caps, flashing, trim, and other items required for a complete installation.
- E. Finish: Baked on Kynar, with 20 year warranty.

### **2.03 ROOF CURBS**

- A. Material: 18 gauge, G-90 galvanized steel, 12 inches high with mitered and continuous welded corners and seams, factory installed pressure treated wood nailers, and rigid fiberglass insulation.
- B. Design: Provide roof curb units manufactured to fit manufactured roof panels. Provide integral water diverter. Design roof curb to support weight of equipment. Coordinate roof curb unit with roof panel manufacturer to ensure proper fit. Roof curb shall be approved for use by manufacturer.
- C. Accessories: Provide interior liner, flashing, trim and other items required for a complete installation.

### **2.04 GRAVEL STOPS**

- A. Fascia: 0.050 inches extruded aluminum of 6063-T5 alloy.
- B. Cant Dam: Commercial 24 gauge galvanized steel.
- C. Concealed Splice Plates: 0.032 inches aluminum and finished to match fascia. Allow 1/4" at ball butt joints per twelve feet of length for expansion.
- D. Accessories
  - 1. Prefabricated Corners: Provide manufacturer's standard mitered and welded units.
  - 2. Scuppers: Manufacturer's standard.
- E. Finish: Color Anodized in accordance with AA-C22A44, Class 1 or Clear Anodized in accordance with AA-C22A41 or "Baked" on Kynar, with 20 year warranty.

### **2.05 COPINGS**

- A. Material: 0.050 inches aluminum with smooth surfaces.
- B. Splice Plate: Aluminum and finished to match coping. Provide six inch wide units at twelve foot centers with extruded butyl seal strips.
- C. Anchor Plate: Galvanized steel. Anchor to substrate with anchors as recommended by manufacturer.

- D. Finish: Color Anodized in accordance with AA-C22A44, Class 1. \*\*\* or Clear Anodized in accordance with AA-C22A41 or "Baked" on Kynar, with 20 year warranty.
- E. Guarantees: Twenty year performance guarantees relative to blow-off, leaktightness and finish.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION - GENERAL**

- A. Install roof accessories and specialties in accordance with the manufacturer's instructions. Provide a complete watertight and weatherproof installation. Install with provision for expansion and contraction.

#### **3.02 DAMAGED MATERIAL**

- A. Repair or replace materials damaged during installation.

#### **3.03 ADJUSTING AND CLEANING**

- A. Check levels and adjust as necessary after roofing and flashing is complete.
- B. Protect materials from damage by other trades. Remove protective coatings at completion of project.

**END OF SECTION**



**SECTION 07 90 00**  
**JOINT FILLERS, SEALANTS AND CAULKING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

**1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C-920 – Elastomeric Joint Sealants
2. ASTM D-1056 – Flexible Cellular Materials – Sponge or Expanded Rubber
3. SWRI – Sealant and Caulking Guide Specification

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
  1. Manufacturers literature and installation instructions. Label each product submitted with Type as indicated in paragraph 2.01 A.
  2. Color samples of each type of sealant.

**1.04 QUALITY ASSURANCE**

- A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years of experience.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials in unopened labeled packages.
- B. Store materials in location protected from freezing or damages.
- C. Reject and remove from the site materials within broken or damaged packaging.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

#### **A. Sealants**

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.
2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by Master Builders Solutions.
3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C920, Type S, Grade NS, Class 50, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by Master Builders Solutions.
4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by Master Builders Solutions.
5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by Master Builders Solutions.
6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.
7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.
8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type M, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, MasterSeal CR 195 by Master Builders Solutions.

- B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.

- C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.
- D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.
- E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.
- F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

### **PART 3 – EXECUTION**

#### **3.01 QUALITY CONTROL**

- A. Coordinate work with details shown on approved shop drawings prepared by other trades.
- B. Verify conditions in the field.
- C. Schedule work to follow closely the installation of other trades.
- D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.
- E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

#### **3.02 PREPARATION**

- A. Protect finished surfaces adjoining by using masking tape or other suitable materials.
- B. Clean and prime joints before starting any caulking or sealing work.
- C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.
- D. Joint Requirements
  - 1. All joints and spaces to be sealed in exterior work shall be less than 1/2-inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.

2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4-inch deep, the back-up material may be omitted, a bond breaker substituted and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4-inch depth of the open space in any joint. The following width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

Joint Width	Sealant Depth	
	Minimum	Maximum
1/4 inch	1/4 inch	1/4 inch
Over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
Over 1/2 inch to 1 inch	1/2 inch	Equal to width
Over 1 inch to 2 inches	1/2 inch	1/2 of width

**3.03 APPLICATION**

- A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.
- B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.
- C. All joints shall be waterproof and weathertight.
- D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.
- E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.
- F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

**3.04 ADJUSTMENT AND CLEANING**

- A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.
- B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

**3.05 SCHEDULE**

**Schedule of Sealants**

<b>Application</b>	<b>Sealant</b>	<b>Color</b>
Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings.	Type 1	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural stone or other porous building material, unless noted otherwise herein or on Drawings.		
Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints equal or greater than 1¼ inches wide and not to exceed 2".		
Interior – wood trim and finish joints.		
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. <sup>2</sup>	Type 2 OR Type 3	To closely match adjacent surfaces and as selected by the Owner.
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. <sup>3,4</sup>	Type 1	
Submerged in liquids with high concentration of chlorine (> 2 ppm) or wastewater.	Type 7	Manufacturer's standard
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the Owner.

- <sup>1</sup> Sealant for Laboratory Countertop shall be as recommended by countertop manufacturer.
- <sup>2</sup> Provide UL approved sealants for penetrations thru fire-rated walls .
- <sup>3</sup> Sealants which will come in contact with potable water shall meet the requirements of NSF 61.
- <sup>4</sup> Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

**END OF SECTION**

**SECTION 09 90 00**

**PAINTING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.
- B. Section Includes:
  - 1. Paint Materials
  - 2. Shop Painting
  - 3. Field Painting
    - a. Surface Preparation
    - b. Piping and Equipment Identification
    - c. Schedule of Colors
    - d. Work in Confined Spaces
    - e. OSHA Safety Colors

**1.02 RELATED SECTIONS**

- A. Section 40 05 97 – Piping and Equipment Identification Systems
- B. Section 07 90 00 – Joint Fillers, Sealants, and Caulking

**1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
  - 1. SSPC – The Society for Protective Coatings Standards
    - a. SSPC-Vis 1 – Pictorial Surface Preparation Standards for Painting Steel Structures
    - b. SSPC-SP2 – Hand Tool Cleaning

- c. SSPC-SP3 – Power Tool Cleaning
  - d. SSPC-SP5/NACE 1 – White Metal Blast Cleaning
  - e. SSPC-SP6/NACE 3 – Commercial Blast Cleaning
  - f. SSPC-SP7/NACE 4 – Brush-off Blast Cleaning
  - g. SSPC-SP10/NACE 2 – Near-White Metal Blast
  - h. SSPC-SP11 – Power Tool Cleaning to Bare Metal
  - i. SSPC-SP13/NACE6 – Surface Preparation of Concrete
2. ICRI – International Concrete Repair Institute
  3. NACE – National Association of Corrosion Engineers
  4. NAFP – The National Association of Pipe Fabricators
  5. ASTM D1737 – Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
  6. ASTM B117 – Method of Salt Spray (Fog) Testing
  7. ASTM D4060 – Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser
  8. ASTM D3359 – Method for Measuring Adhesion by Tape Test

#### **1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
  1. Manufacturer's literature and Material Safety Data Sheets for each product.
  2. Painting schedule identifying surface preparation and paint systems proposed. Cross reference with Tables 1 and 2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items. Manufacturer shall substitute paint system with equal performance where required for VOC compliance.
  3. Contractor shall submit Q.C. Inspection plan describing all tests and inspections task to be performed. Include copy of daily log showing environmental conditions



measurements and frequency. Copy of completed log shall be provided at completion of work.

### **1.05 SYSTEM DESCRIPTION**

- A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenances.
- B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.
- C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.
- D. Submerged ferrous metal, piping, and internal pump surfaces within potable water facilities or potable water distribution systems shall be painted with NSF 61/600 approved coatings.
- E. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

### **1.06 QUALITY ASSURANCE**

- A. Painting operations shall be accomplished by skilled craftsman and licensed by the state/commonwealth to perform painting work.
- B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.
- C. Contractor shall coordinate Q.C Inspections.
- D. Notify Owner and Engineer at completion of surface preparation, priming application and final cure to allow inspection by Owner and Engineer or their Third-Party Inspector.

### **1.07 STORAGE AND DELIVERY**

- A. Bring materials to the job site in the original sealed and labeled containers.

- B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

## **PART 2 – MATERIALS**

### **2.01 GENERAL INFORMATION**

- A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.
- B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.
- C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.
- D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.
- E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.
- F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

## **2.02 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
  - 1. Tnemec Company Inc.
  - 2. PPG
  - 3. CARBOLINE
  - 4. Sherwin-Williams
  - 5. International Paints (Akzo Nobel)

## **PART 3 – EXECUTION**

### **3.01 SHOP PAINTING**

- A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.
- B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.
- C. Coordinate shop painting and field coating to ensure item is delivered and field coating occurs within recoat window of shop painted system requirements.

### **3.02 SURFACE PREPARATION**

- A. General
  - 1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.
  - 2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.

3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.
4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.
5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touchup coats are in addition to the specified applied systems, and not considered a field coat.
6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.
7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

#### B. Metal Surface Preparation

1. Prepare all welds to a minimum NACE weld preparation level "C" per NACE Standard SP0178. Provide additional weld preparation where required by the coating manufacturer. Contractor shall provide NACE SP0178 weld mold visual aids on site for evaluation of all weld preparation.
2. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.
3. Perform blast cleaning operations for metal when following conditions exist:
  - a. Moisture is not present on the surface.
  - b. Relative humidity is below 80%.
  - c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.

- d. Painting or drying of paint is not being performed in the area.
  - e. Equipment is in good operating condition.
  - f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.
4. Abrasive blast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.
  5. Abrasive blast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service. Provide a 3.0 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
  6. Abrasive blast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment or weathering exposure. Provide a 1.5 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
  7. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system. Galvanized metal shall be prepared in accordance with SSPC SP-16. Abrasive blast clean to increase mechanical adhesion in accordance with ASTM D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting when required by coating manufacturer. Provide a 1.5 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
  8. Abrasive blast clean internal and external ductile iron pipe surfaces prior to coating in accordance with NAPF 500-03-04, Surface Preparations Standard for Abrasive Blast Cleaning of Ductile Iron Pipe. Abrasive blast clean internal and external cast ductile iron and cast-iron fitting surfaces in accordance with NAPF-03-05.
  9. Prime cleaned metals immediately after cleaning to prevent rusting.
  10. Clean rusted metals down to bright metal by abrasive blasting and immediately field primed.

#### C. Concrete Surface Preparation

1. Cure concrete a minimum of 28 days at 75° F before surface preparation, and painting begins. Allow more time at lower temperatures if specified by paint manufacturer.

2. Test concrete for pH and salts using test methods recommended by the paint manufacturer. A minimum of one test per 1000 square feet of area to be coated shall be performed unless approved otherwise by Engineer. Do not begin surface preparation, or painting until acceptable to manufacturer.
3. Moisture content of concrete and masonry surfaces shall conform to manufacturer's recommended limits, and as listed in SSPC-SP13/NACE 6 Section 6 Acceptance Criteria Table 1. Floor surfaces to be coated shall be tested in accordance with ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride or as required by the coating manufacturer. Moisture vapor transmission shall not exceed three pounds per 1,000 square feet in a 24-hour period or less if specified by Coating Manufacturer. Vertical and horizontal overhead surfaces shall be tested in accordance with ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete using in situ Probes (relative humidity shall not exceed 80% or as required by the coating manufacturer) or with ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Test Method (test results shall be no moisture present). Engineer or Coating Manufacturer Representative shall specify all test locations. A minimum of one test per 1000 square feet of area to be coated shall be performed unless approved otherwise by Engineer.
4. Prepare concrete surfaces to receive coatings in accordance with NACE 6/SSPC-13 – Joint Surface Preparation Standards and ICRI Technical Guidelines. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities using abrasive blasting, shot blasting, water jetting or mechanical abrading. Use dry, oil-free air for blasting operations. Surface texture after blasting shall achieve profile as required by manufacturer or where not defined by manufacturer, profile shall be a minimum ICRI-CSP 5 surface profile. Remove residual abrasives, dust, and loose particles by vacuuming or other approved method.
5. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric or waterborne epoxy cementitious filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.
6. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.
7. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

8. To ease coating around outside corners, provide  $\frac{3}{4}$ -inch chamfered edges on all new concrete outside corners and grind existing concrete outside corners to a minimum radius of  $\frac{3}{4}$ -inch.
9. Unless recommended otherwise by the coating manufacturer, provide  $\frac{1}{4}$ " deep by  $\frac{1}{4}$ " wide tool cut terminations at 1-inch maximum from all coating edges for anchorage. Provide terminations around all equipment, piping, openings, gates, top and bottom of walls, stop locations of each day's work and overlap onto previously completed work. Transition coating 3-inches onto interior lining of piping except where coating compatibility concerns are noted by coating manufacturer.
10. Apply epoxy or polymeric filler compatible with painting system to all inside corners of areas to be coated with a margin trowel to form a continuous 45-degree cant cove across corners with a minimum dimension of 1.5-inch. Roughen or prepare cured filler as recommended by coating manufacturer for proper coating adhesion.
11. All equipment grouting shall be installed and cured prior to starting coating work. Coating shall be applied over grout up to the edges of all equipment, gates and uninterrupted piping unless specifically noted otherwise.

#### D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.
2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.
3. Prime and backprime wood trim before setting in place.
4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

#### E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.
2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

#### F. Masonry

1. Cure for a minimum of 30 days prior to paint application.
2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.
3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

#### G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.
2. Remove dust, dirt, and other contaminants.

#### H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.
2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.
3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.
4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.
5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

### 3.03 APPLICATION OF PAINT

- A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.
- B. Apply paint without runs, sags, thin spots, or unacceptable marks.
- C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.



- D. Special attention shall be given to nuts, bolts, edges, angles, flanges, welds, etc., where insufficient film thicknesses are likely. Stripe paint outside corners and edges in accordance with SSPC PA Guide 11. Stripe painting shall be in addition to coats specified.
- E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.
- F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.
- G. Suspend painting when any of the following conditions exist:
  - 1. Rainy or excessively damp weather.
  - 2. Relative humidity exceeds 85%.
  - 3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.
  - 4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.
  - 5. Surface temperature of item is within 5 degrees of dewpoint.
  - 6. Dew or moisture condensation are anticipated.
  - 7. Surface temperature exceeds the manufacturer's recommendations.
- H. Where application of coating across concrete control joints or expansion joints has the potential to crack, turn coating into joints and caulk joints with a sealant compatible with coating rated for the intended service per Section 07 90 00 – Joint Fillers, Sealants, Caulking.

### **3.04 INSPECTION**

- A. Each field coat of paint will be inspected and approved by the Engineer or the Engineer's authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.
- B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

- C. Coatings shall pass a holiday detector test.
- D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.
- E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.
  - 1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, 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 specified coating thickness.
  - 2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.
- F. Paint manufacturer's NACE certified representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

### **3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES**

- A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.

- B. Take all necessary precautions to contain dispersion of abrasive blasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the abrasive blasting debris and paint. Suspend painting operations when abrasive blasting debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

### **3.06 PIPING AND EQUIPMENT IDENTIFICATION**

- A. Piping and equipment identification shall be in accordance with Section 40 05 97 – Piping and Equipment Identification Systems.

### **3.07 SCHEDULE OF COLORS**

- A. Match colors indicated. Piping and equipment colors are indicated in Section 40 05 97 – Piping and Equipment Identification Systems. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

### **3.08 WORK IN CONFINED SPACES**

- A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forceddraft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosionproof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state/commonwealth, and local regulations at all times.

### **3.09 OSHA SAFETY COLORS**

- A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not to exceed 2 feet wide by 3 feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.
- B. Paint hazardous areas and objects in accordance with OSHA regulations.

### **3.10 VOC REGULATIONS**

- A. Provide paint systems in accordance with local, state, and federal regulations. Where paint systems shown in schedule do not comply, substitute equal products with VOC limits which comply with local, state, and federal regulations.

**Table 1: Painting Schedule**

Surface	Application	Painting System and No. of Coats	Product Reference (Table 2)	Total Min. Dry Film Thickness (Mils)
<b>Concrete and Masonry</b>				
Interior masonry and concrete walls, columns, beams, and ceilings	All new structures	1 coat sealer 2 coats acrylic epoxy	101 116	75-85 sq.ft./gal. 4-6/coat
Interior masonry and concrete walls, columns, beams, and ceilings in chemical rooms		1 coat sealer 2 coats epoxy polyamide	117 102	60-80 sq.ft./gal. 4-6/coat
Exterior masonry cavity walls on cavity face of inner wythe	All new structures	Dampproofing	See Section 07 11 00	
Submerged or occasional contact with potable or raw water	Water retaining side of new wall surfaces where opposite side of wall is interior and dry and where indicated "epoxy waterproofing" on drawing	2 coats NSF 61/600 approved epoxy polyamide Provide filler as required and recommended by manufacturer	105	4-6/coat
Submerged wastewater	Water retaining side of new wall surfaces where opposite side of wall is interior and dry and where indicated "epoxy waterproofing" on drawing	2 coats high solids epoxy Provide filler as required and recommended by manufacturer	119	6-10/coat
Containment Liner <sup>1</sup>	Interior and exterior secondary containment floors, tank supports and walls	2 coats high solids epoxy coating	119	6-10/coat
<b>Metals</b>				
Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer 1 coat epoxy polyamide 1 coat aliphatic polyurethane	104 102 115	4-6 4-6 3-5
Interior insulated		1 coat acrylic latex	103	4
Submerged or occasional contact with potable or raw water	All metal piping, mechanical equipment, etc.	2 coats NSF 61/600 approved epoxy polyamide	105	4-6/coat
Submerged Wastewater		2 coats high solids epoxy	119	8-10/coat
Steel doors, windows and door frames, steel stairs, monorails, structural steel, misc. metals (steel), galvanized lintels,		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26

Surface	Application	Painting System and No. of Coats	Product Reference (Table 2)	Total Min. Dry Film Thickness (Mils)
Shop Primed Structural Steel	Pre-Engineered Buildings	1 tie coat	113	2-3
		1 coat epoxy	114	3-4
		1 coat epoxy	120	3-4
<b>Other</b>				
Interior: Gypsum Wallboard	All new structures	2 coats acrylic latex matte or satin	103	2-3/coat
Interior: Tar-dipped piping where color is required		1 coats epoxy resin sealer	112	2-3/coat
		1 coats epoxy polyamide	102	5-8/coat
PVC Piping		1 coat epoxy polyamide	102	5-8
		1 coat aliphatic polyurethane	115	3-4

1 Painting manufacturer shall verify compatibility of containment liner and chemical to be contained. Where incompatible substitute a compatible coating system.

Ref.	System	Purpose	Product			
			Tnemec Series	PPG	CARBOLINE	Sherwin-Williams
101	Acrylic filler	Primer-sealer	130-6601	BLOXFIL 400BF	Sanitile 100	Pro-Industrial Heavy Duty Block Filler
102	Epoxy polyamide	Finish coat semi-gloss or gloss	N69	AMERLOCK 600 (SEMI-GLOSS)	Carboguard 890	Macropoxy 646
103	Acrylic latex	Sealer	1028/1029	PITT TECH PLUS	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 600	Carboguard 893SG	Macropoxy 646
105	Epoxy polyamide	Primer/Finish	L140	AMERLOCK 2 VOC	Carboguard 61/891VOC	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	HP INDUSTRIAL ALKYD 4308	Carbocoat 8215	Industrial Enamel
109	Alkyd-long oil	Finish coat	1029	HP INDUSTRIAL ALKYD 4308	Carbocoat 8215	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 600	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERLOCK SEALER	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	AMERLOCK SEALER	Rustbond	-
114	Polyamine Epoxy	Intermediate coat	27	AMERLOCK 600	Carboguard 893SG	-
115	Aliphatic Polyurethane	Finish coat	1094 or 1095	PITTHANE ULTRA SERIES	Carbothane 134HG	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AQUAPON WB EP	Sanitile 255	Pro-Industrial Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	1254	AMERLOCK 400BF	Sanitile 500	Kem Cati-Coat HS Epoxy Filler
118	Catalyzed epoxy	Finish coat	84	AMERLOCK 2/400	Carboguard 890	Macropoxy 646

Ref.	System	Purpose	Product			
			Tnemec Series	PPG	CARBOLINE	Sherwin-Williams
119	High solids epoxy	Finish coat	104	AMERLOCK 240	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	AMERLOCK 240	Carboguard 890	-

**Table 2: Product Listing**

**END OF SECTION**

**SECTION 22 05 00**  
**COMMON RESULTS FOR PLUMBING**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Furnish services, skilled and common labor, and apparatus and materials required for the complete installation as shown and within the intent of the drawings and/or these Specifications.
2. Requirements of this Section apply to Division 22 Sections.

C. Related Sections:

1. Section 00 72 00 – General Conditions
2. Section 00 73 00 – Supplementary Conditions
3. Section 01 75 00 – Checkout and Startup Procedures
4. Section 26 05 00 – Basic Electrical Requirements
5. Section 01 73 23 – Seismic Anchorage and Bracing
6. Division 09 Sections on paints and coatings

**1.02 REFERENCES**

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.



- B. Refer to Section 00 72 00– General Conditions for the list of applicable regulatory requirements.
1. Comply with Section 01 73 23 – Seismic Anchorage and Bracing.
- C. DESCRIPTION
- D. These Division 22 specifications define the statutory, administrative, procedural, and technical requirements of the mechanical and controls modifications, replacements, and/or upgrades products and services to be provided on this Subcontract.
- E. Provide plumbing work as indicated on the Drawings and specified in Division 22 including:
1. Prepare coordination drawings, shop drawings, submittals, as-built drawings, and operating and maintenance instructions.
  2. Determine items and quantities required.
  3. Provide complete, continuous, operational, and functioning systems.
  4. Fully coordinate with work of other Sections, including field verification of elevations, dimensions, clearance, and access.
  5. Repair of all damage done to premises as a result of this installation and removal of debris left by those engaged in this installation.
  6. Rigging, hoisting, transportation, and associated work necessary for placement of equipment in the final location shown.
  7. Disassembly and re-assembly of equipment furnished under this Section, should this be required in order to move equipment into final location shown on the Drawings.
  8. Labor, materials, tools, appliances and equipment that are required to furnish and install the complete installation for this section of the work including that which is reasonably inferred.
  9. Cooperation with other crafts in putting the installation in place at a time when space required is accessible.
  10. Temporary scaffolding necessary for performance of the work in this Division.
  11. Cutting and core drilling required for work of Division 22, including locating of rebar or coordination of locating rebar with the General Contractor.

12. Pipe sleeves for all holes in walls, floors, and ceilings, and cutting of floor slabs and slabs on grade.
13. Waterproofing where necessary for installation under this Division.
14. Cooperation with and assistance to the Facilities Monitoring and Control System Contractor as required to provide a complete and functional plumbing system.
15. Counterflashing of roof penetrations for work of Division 22.
16. Sizes, and locations for installation of any curbs and pads for work of Division 22.
17. Temporary and permanent stands and supports for equipment requiring them including vibration isolation.
18. Temporary protection of existing installation.
19. Stenciling and equipment identification.
20. Firestopping of penetrations of ducts, piping, and conduits through walls, floors, and ceiling assemblies.
21. Temporary utilities as required to install work on Division 22 including lighting, water, gas, electricity, etc.
22. Fees, permits, inspections, taxes, and approach from agencies that have jurisdiction over installation of Division 22.
23. Participation in and coordination with the Commissioning process.
24. Warranty.

### **1.03 SUBMITTALS**

- A. Submit under provisions of Section 00 72 00 – General Conditions
- B. Product Data: Submit manufacturer's technical product specification sheets for each system component and device to be provided that includes data needed to prove compliance with this specification. Clearly indicate the exact model of each component to be provided.
- C. Shop Drawings: The Subcontractor shall submit for approval shop drawings prepared in accordance with Section 01 33 00 – Submittal Procedures and as required by other Sections of these specifications.
  1. Shop drawings shall be drawn to a scale of 1/4 inch = 1 foot (1:25) or larger, and shall include complete dimensions, locations, elevations, and clearances for plumbing, piping, ductwork, equipment, and valve numbers.

- a. Prepare in AutoCad 2017 format or as otherwise directed.
  - b. Identify equipment using designations shown on the Contract Documents or as directed by the Owner's Representative. Do not proceed with identifications without approval from the Owner's Representative.
2. All shop drawings shall clearly call out in bold letters and cloud symbols deviations from the specifications and contract documents, no matter how minor.

D. Coordination Drawings:

1. Obtain drawings from the structural, electrical, sprinkler, plumbing, sheet metal, concrete, steel, and dry wall trades.
2. Hold regular coordination sessions with trades until coordination issues are resolved.
3. Prepare separate composite coordination drawings to a scale of 1/4 inch = 1 foot (1:25) or larger, showing work of Divisions to demonstrate coordination, clearance, access, etc. between ductwork, equipment, temperature controls, cable trays, conduits, light fixtures, piping, plumbing, structural elements, architectural elements, etc. These drawings are to be the basis for the detailed shop drawings and need not be submitted, but are to be available for review upon request.
  - a. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  - b. Each trade is to adjust their shop drawings based on the outcome of coordination sessions.
4. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work.
5. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
6. Indicate the proposed locations, of piping, ductwork, equipment, and materials. Include the following:
  - a. Clearances for installing and maintaining insulation.
  - b. Clearances for servicing and maintaining equipment, including specific ceiling tile or ceiling access panel access and space for equipment disassembly required for periodic maintenance.

- c. Equipment connections and support details.
  - d. Fire-rated wall and floor penetrations.
  - e. Sizes and location of required concrete pads and bases.
  - f. Valve stem movement.
  - g. Sizes and locations of new and existing equipment support curbs on roof.
  - h. Sizes and locations of new openings, either sleeved, cut, or core-drilled, in new concrete construction unless specifically shown on the Structural Drawings.
- 7. Maintain one complete set of composite coordination drawings at the job site. Periodically update drawings based on actual field conditions.
  - 8. Submit final coordination drawings as part of record document requirements.
- E. Submit manufacturer's operation and maintenance manuals in compliance with Section 07 78 23 – Operation and Maintenance Data. Include a list of spare parts that the manufacturer recommends the Owner purchase.
  - F. Lateral Force Anchorage: Submit lateral force anchorage calculations and details of anchorage of components to building including backing design. Seismic forces shall be in accordance with Section 01 73 23 – Seismic Anchorage and Bracing with value 1.5 used as the minimum CBC seismic importance factor,  $I_p$ . Calculations shall be sealed by a Structural Engineer registered in the State or Commonwealth in which the project is located.
  - G. Record Documents: Upon completion of the work covered by this Contract, as directed, furnish as-built drawings as specified in Division 01. Include changes installed under this Contract which are not in accordance with the Contract Drawings. Note that these as-built drawings are to be based on the Contract Drawings. In addition, submit final copies of the Shop Drawings and Coordination Drawings.

#### **1.04 QUALITY ASSURANCE**

- A. Materials and Equipment: materials and equipment shall be new. Materials and equipment for which tests have been established by Underwriter's Laboratories, Inc. shall be approved by that body and shall bear its label of approval.
  - 1. The first named manufacturer and product is the basis of design. Other manufacturers and/or products are considered as substitutions.
- B. In lieu of listing by an approved testing laboratory, consideration will be given to certified test reports of an adequately equipped, recognized independent test laboratory

competent to perform such testing indicating conformance to requirements of the applicable Underwriter's Laboratories, Inc. standards.

- C. Unless otherwise approved by the Project Manager, the materials to be furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such equipment equal to or superior to the material specified, and shall be the manufacturer's latest standard design that complies with the specification requirements.
- D. Approval of Materials:
1. Section 00 72 00 – General Conditions requirements for Materials and Equipment and Submittals.
  2. A complete list of materials and equipment proposed shall be submitted to the Project Manager for approval. The list shall include for each item: the manufacturer, the manufacturer's catalog number, type or class, the rating, capacity, size, etc.
  3. Before installation of the equipment, the Subcontractor shall submit for approval detailed construction drawings for each item of fabricated equipment required for installation. Drawings shall be to scale and fully dimensioned and shall provide sufficient detail to clearly indicate the arrangement of equipment and its components.
  4. Installation of approved substituted equipment is the Subcontractor's responsibility, and changes required to work included under other divisions for installations of approved substituted equipment must be made to the satisfaction of the Owner's Representative and without change in contract price. Approval by the Owner's Representative of substituted equipment and/or dimension drawings does not waive these requirements.

#### **1.05 START-UP TRAINING**

- A. Prepare a formal training program for operating staff prior to the scheduled start-up date. The program will consist of the design, start-up, and operation of the mechanical, plumbing, fire protection, and building automation systems. Coordinate the training program with the production of the operation and maintenance manuals. Provide indexed binder and training materials to each participant.
- B. Provide 16 hours (unless specified otherwise) of on-site training in the operation and maintenance for installed system and major piece of equipment. Systems include boilers and heating hot water system, chillers and chilled water system, plumbing, fire protection, air supply and exhaust systems, air conditioning units, balancing, and Facilities Monitoring and Control System. Trainers shall be experienced, manufacturer-approved personnel.
1. Schedule training for each system in advance with the Owner's Representative.

2. Include travel, per diem and incidental costs for personnel under contract to the Subcontractor.
3. Operations and Maintenance data to be available for training sessions.

#### **1.06 RULES AND REGULATIONS**

- A. See Division 01.
- B. Provide work and materials in full accordance with the latest rules of the organizations listed in Division 01 and in other Sections of Division 22, and with prevailing rules and regulations pertaining to adequate protection and/or guarding of moving parts, or otherwise hazardous locations.
- C. Whenever the Drawings and Specifications require something which will violate the regulations, the regulations shall govern. Review the Drawings and Specifications, and request from the Owner's Representative clarification or revision of portion of the work in violation of the rules or regulations prior to installing the work. Necessary installation alteration required for compliance shall be made at no additional cost to the Owner.
- D. Whenever the Drawings and Specifications require larger sizes, or higher standards than are required by the regulations, the Drawings and Specifications shall govern.
- E. Strictly conform to the requirements of the National Fire Protection Association, National Electrical Code, International Building Codes, OSHA, Fire Marshal, and insurance underwriters' requirements. expenses required shall be borne under this Contract.

#### **1.07 PROTECTION OF EQUIPMENT**

- A. Protect, handle, and store products under provisions of Division 01.
- B. Assume responsibility for damage to of the work or premises before substantial completion. Should new or existing equipment become damaged, restore it to its original condition and finish before final acceptance. Damage incurred to the property or to the work of other Divisions, caused by this Division, shall be replaced or repaired by, and at the expense of, the Subcontractor to the satisfaction of the Owner's Representative. Exposed materials shall be clean at the time of acceptance of the project.

#### **1.08 SCHEDULING AND SEQUENCING**

- A. Cooperate with other trades in putting this installation in place at a time when space required is accessible, and in such a manner that other work in this space may be installed as shown on the Drawings. Schedule work and cooperate with the others to avoid delays, interferences, and unnecessary work, conforming to the construction schedule, making the installation when and where directed.

- B. Include labor and materials to install certain items furnished under this contract when required by the schedule. These items are part of this contract but may need to be installed only after completion of work under another contract which this contractor may or may not be participating in. It is the responsibility of this contract to coordinate with others to ensure that preparations are made and ready to accept the installation of these items. These items include, but are not limited to:
  - 1. Air inlets and outlet
  - 2. Temperature sensors.
  - 3. Monitoring and control panels.
  - 4. Sprinkler heads.
- C. If a discrepancy is discovered between engineering and architectural Drawings, whether with respect to a significant variance between location, variation in quantity, or violation of code requirements, notify Architect for clarification and do not proceed with the work affected until clarification has been made.
- D. Schedule work in advance with the Owner's Representative. No system shall be shutdown unless approved in writing.

#### **1.09 TEMPORARY USE**

- A. Should it become necessary to use the new portion of the system and the new equipment to warm or air condition part of the building before the completion of this work, the Owner reserves the right to make use of same at its own risk and expense, but the temporary use of the equipment shall not constitute an acceptance of the plant or part thereof in way. The Owner will bear the cost of fuel and electrical current for such temporary use of the equipment. If temporary use of new systems or equipment is solely for the benefit of the contractor, contractor shall bear the cost of fuel and electrical current for such temporary use.

#### **1.10 WARRANTY**

- A. Comply with Section 00 72 00 – General Conditions.
- B. Provide extended warranties where specifically required in subsequent sections of Division 22.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. In addition to material and equipment specified, provide incidental materials to effect a complete installation. Such incidental materials include solders, tapes, caulking, mastics, gaskets and similar items.
- B. Materials and equipment shall be uniform throughout the installation. Equipment of the same type shall be of the same manufacturer. materials and equipment shall be new.

### **2.02 MATERIALS AND SUBSTITUTIONS**

- A. Comply with Section 00 72 00 – General Conditions.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION OF SITE**

- A. Examine the site and become familiar with conditions that may affect the work covered by this Division of the Specifications.
- B. Arrange to meet with the Owner's Representative at the job site before the work is started and discuss with them the various phases of the work and the procedure and preparation for testing and adjusting the systems.
- C. The general arrangement and location of piping ductwork, apparatus, etc., is shown on the Drawings or herein specified. Minor changes may be necessary to accommodate other work, new or existing, that may conflict with this work. Install this work in harmony with these trades and fully coordinate work.
- D. Visit the site of the work, take measurements, examine areas where work is to be performed and get such other information necessary for proper execution of the work. Ascertain and check conditions with the Drawings and Specifications, other trades, existing conditions and by what means the work is to be performed. No allowance shall subsequently be made for extra expense due to failure or neglect to make such examination and correlation. Where revisions or changes in the existing work are required to permit the installation of new work, they shall be made at no additional cost to the Owner. No allowance shall be subsequently made for error or omission.

### **3.02 ACCURACY OF DATA**

- A. The Drawings indicate the general arrangement and location of piping, ducts, and equipment. Should it be necessary to deviate from arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with other work, make such deviations as offsets, rises and drops in piping and ducts that may be



necessary, whether shown or not, without extra expense to the Owner. Extreme accuracy of the data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for the assistance and guidance of this Section and exact locations, distances, and elevations shall be governed by actual site conditions.

### 3.03 COORDINATION ITEMS

- A. Coordinate mechanical work with that of other trades in order to:
1. Avoid interferences between general construction, mechanical, electrical, structural and other specialty trades.
  2. Maintain clearances and advise other trades of clearance requirements for operation, repair, removal and testing of mechanical equipment.
  3. Indicate aisleways and accessways required on coordinated shop drawings for roof equipment area, mechanical equipment rooms, data and telecomm rooms, corridors, ceiling spaces, shafts, corridors, ceiling space, laboratories, etc.
- B. Understanding of Work:
1. Study, examine, and compare of the contract documents, including drawings and specifications. The Subcontractor shall have a full understanding of how the work in this part is scheduled, phased, and installed with work of other trades.
  2. Include in this installation piping, ductwork, devices, and equipment that are necessary for complete and operating systems as specified and as required.
  3. Connect piping and ductwork from fixtures, outlets, and devices full size to the nearest suitable main or riser.
  4. Certain installations may be presented as typical, and full details are not repeated for each case. Subcontractor shall provide complete installation as if full details apply to each and every case and make adjustments to typical details to suit each specific installation as part of the basic work.
  5. Installation of work presented on the diagrams are applicable to the plans, and work depicted on the plans are applicable to the diagrams.
  6. If there is a discrepancy in the drawings or specifications, the contractor shall figure the work based on the most stringent requirements to complete the installation and obtain clarification from the Architect before installation.
- C. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. Work shall be above ceilings or ceiling line.
7. Coordinate installation and connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Coordinate with individual system requirements.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as is practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
12. Coordinate with the locations of electrical panels and avoid installing piping and ductwork over them. Electrical panels are purposely located and have priority for location. The contractor is responsible for required piping and ductwork offsets to ensure that the panels are located as designed and for other conditions.

13. Perform system modification recommended by Test and Balance Agency after recommendations are accepted by the Owner's Representative.

### **3.04 WORKMANSHIP AND SUPERVISION**

- A. Comply with of the following:
- B. General Requirements: Section 00 72 00 – General Conditions
- C. Special Requirements:
  1. Measurements: Materials installed shall be to exact field measurements.
  2. The installation depicted on the Drawings is designed to fit tightly into work under other Sections or Divisions. It is the essence of this Contract that work be completely coordinated with other Sections or Divisions, and that locations of pipes and ducts be exactly determined in the field and cleared with other Sections or Divisions before the installation of these items is begun. No extra compensation will be made for failure to observe this clause.
  3. Adequate clearance for access to operable devices and automatic devices and for access to lubrication points shall be maintained in portions of the work including ductwork and piping installed on the roof. Tripping hazards shall be avoided.
  4. Provide architectural access doors where shown and where required for access to equipment and operable devices.
  5. Gauges, thermometers, and other indicating devices shall be installed so that they can be easily read from the floor.

### **3.05 MATERIAL DELIVERY AND STORAGE**

- A. Comply with Section 01 65 00 – Product Delivery Requirements.
- B. Comply with Section 01 66 00 – Product Storage and Protection Requirements.

### **3.06 INSTALLATION**

- A. Manufacturer's Directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and Specifications. Where these are in conflict with the drawings and Specifications, notify the Project Manager for clarification before installing the work.
- B. Carpentry, Cutting, Patching, and Core Drilling:
  1. Provide carpentry, cutting, patching, and core drilling required for installation of material and equipment specified in this Division.

2. No penetrations shall be sleeved, cut, or core drilled through concrete construction without a submittal indicating exact locations and sizes and specific written approval from the Owner's Representative or unless specifically shown on the Structural Drawings.
  3. It is the Subcontractor's responsibility to accurately size and locate openings through the structure. The dimensions shown on the Structural Drawings are for general information only. Provide specific sizes, dimensions, requirements, etc.
- C. Seismic Mounting:
1. Material and equipment, including floor mounted equipment, piping, and appurtenances shall comply with Section 01 73 23 – Seismic Anchorage and Bracing.
- D. Waterproof Construction:
1. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashings at exterior roof penetrations. Caulk penetrations of foundation walls and floors watertight. Provide membrane clamps at penetrations of waterproof membranes.
  2. Provide waterproof NEMA 3R enclosures for equipment or devices mounted outside or otherwise exposed to the weather.
- E. Sleeves, Stubs, and Slab Penetrations: Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
- F. Painting of Mechanical Equipment and Hardware:
1. Comply with applicable Division 09 sections for paints and coatings.
  2. Provide moisture resistant paint for exterior painting.
  3. Colors shall be as shown on the drawings unless specified.
  4. Comply with individual Sections for other equipment to be painted.
  5. Repair damaged galvanizing, paint, or coatings. Use Z.R.C. (no known equal) cold galvanized compound for galvanized repairs.
- G. Concrete Equipment Bases:
1. All equipment located on concrete floor inside the building or on grade outside the building, shall be mounted on a concrete base. The concrete base shall be four inches high and shall extend six inches beyond the edge of equipment base unless indicated otherwise on drawings.

2. Coordinate concrete bases: Concrete bases indicated on Architectural or Structural drawings are specified in other Divisions. Concrete bases not on Architectural or Structural drawings are requirements of this Division.

### **3.07 PIPING AND EQUIPMENT IDENTIFICATION**

- A. Comply with Section 22 05 53 – Identification for Plumbing Piping and Equipment.

### **3.08 NOISE AND VIBRATION**

- A. Vibration levels shall not exceed vibration criteria listed in Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. If noise or vibration problems are a result of improper material or installation, or exceeds limits by above Paragraphs - 3.03.A and 3.03.B, these conditions shall be corrected by the Subcontractor at no cost to the Owner.

### **3.09 PROTECTION OF EQUIPMENT**

- A. Care shall be exercised during construction to avoid damage or disfigurement. Equipment shall be protected from dust and moisture prior to and during construction. The Subcontractor is cautioned that concrete finishing, painting, etc. in electrical rooms shall not proceed if unprotected equipment is installed.
- B. Where required or directed, construct temporary protection for equipment and installations for protection from dust and debris caused by construction.
- C. All protection shall be substantially constructed with the use of clean canvas, heavy plastic, visqueen and plywood as required, and made tight and dust proof as directed.
- D. The Subcontractor shall repair by spray or brush painting, after properly preparing the surface, scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.
- E. Failure of the Subcontractor to protect the equipment as outlined herein shall be grounds for rejection of the equipment and its installation.

### **3.10 LUBRICATION**

- A. All lubrication points shall be accessible. Where this is impossible, provision shall be made for lubrication at an accessible location. Where oil is used, an oil level indicator and capped, vented filling connection shall be provided and firmly mounted in an accessible space and shall be connected to the bearing with pipe(s) as required. Where grease is used for lubricant, the pipe shall have a suitable lubricating fitting installed at the accessible end. Equipment shall be thoroughly lubricated before operation and at time work is accepted.

**3.11 SEALANTS**

- A. See Division 07 Sections for sealing duct, pipe, and conduit penetrations through walls, partitions, and floors.
- B. Completely seal duct, pipe and conduit penetrations through rated and non-rated walls.

**3.12 TESTS**

- A. Upon completion of the mechanical construction work, perform tests and provide test reports as specified in this and other Sections.
  - 1. All tests shall be made in the presence of a representative of the Project Manager. The application or interruption of mechanical utilities shall be programmed and directed by the Project Manager.
  - 2. The Subcontractor shall submit to the Project Manager 3 copies of test results, certified in writing, witnessed, signed and dated, immediately upon completion of work. Unsatisfactory condition revealed by these test results, or unsatisfactory methods of tests and/or testing apparatus and instruments, shall be corrected by the Subcontractor to the satisfaction of the Project Manager.
  - 3. The Project Manager reserves the right to require that the Subcontractor perform and repeat tests that are deemed necessary to complete or check the tests or the certified records of the Subcontractor during the course of the work. Correct unsatisfactory portion of its work that is revealed by the tests or that may be due to progressive deterioration during this period, unless the item in question was a direct specification.

**3.13 MAINTENANCE AND OPERATING INSTRUCTIONS AND TRAINING**

- A. Refer to Section 00 72 00 – General Conditions for maintenance and operating instructions, and training requirements.
- B. At time of occupancy, arrange for manufacturer's representatives to instruct operating and maintenance personnel in the use of equipment requiring operating and maintenance. Arrange for personnel to be instructed at one time. Costs for this service shall be included in the Subcontract.
- C. Maintenance and operating instructions and training for Owner-furnished equipment will be provided by the equipment vendor. The Subcontractor shall be responsible for other equipment.

**END OF SECTION**

**SECTION 22 05 16**  
**EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Flexible pipe connections.
2. Expansion joints and compensators.
3. Pipe loops, offsets, and swing joints.

C. Related Sections:

1. Section 00 72 00 – General Conditions.
2. Section 22 05 00 – Common Results for Plumbing for codes and standards, and general requirements.
3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

**1.02 REFERENCES**

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00 – General Conditions for the list of applicable regulatory requirements.

4. Refer to Section 22 05 00 – Common Results for Plumbing for codes and standards, and other general requirements.

B. Conform to Standards of Expansion Joint Manufacturer's Association.

### **1.03 SUBMITTALS**

A. Submit under provisions of Section 22 05 00 – Common Results for Plumbing - Review of Materials, Section 00 72 00 – General Conditions and Section 01 33 00 – Submittal Procedures.

B. Flexible pipe-connector Shop-Drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose-wall thickness, hose convolutions per foot (300 mm) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

C. Expansion joint Shop Drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation plus 30 percent safety factor.

## **PART 2 – PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

A. Metraflex

B. Flexonics

### **2.02 FLEXIBLE PIPE CONNECTIONS**

A. For steel piping, construct with stainless steel inner hose and braided exterior sleeve.

B. For copper piping, construct with bronze inner hose and braided exterior sleeve.

C. Use connectors suitable for at least 125-psi WSP and 450 deg F (232 deg C), and 200-psi WOG and 250 deg F (121 deg C).

1. SWP Rating: 150 psig (1035 kPa).

2. CWP Rating: 600 psig (4140 kPa).

D. Construct spool pieces to exact size for insertion of flexible connection.

### **2.03 EXPANSION JOINTS - LOOP TYPE**

A. Metraflex Metraloop, Hyspan, Unisource, or equal.



- B. Each loop shall be complete with braided hose, bends, and pipe connection. Contractor is to engineer the systems to absorb the intended pipe expansion without imparting thrust loads. Flexible hoses shall be 304 stainless steel. Pipe materials and end connections shall match pipe used in the system.

## **2.04 CONNECTIONS**

- A. Provide flexible pipe connections and expansion joints suitable for connection to adjoining piping as specified for pipe joints. Use units which are the same size diameter as the pipe into which they are being inserted.
- B. Verify building expansion separations with structural drawings before ordering expansion loops.

## **PART 3 – EXECUTION**

### **3.01 INSPECTION**

- A. Examine piping layout and notify the Owner's Representative of additional anchors or expansion joints required to adequately protect system.
- B. Provide inspection services by flexible pipe manufacturer's representative for final installing and certify that installation is in accordance with manufacturer's recommendations and that connectors are performing satisfactorily.

### **3.02 INSTALLATION**

- A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.
- B. Install expansion joints on pipes where required for seismic joint bridging or thermal expansion compensation.
- C. Provide equipment required to control expansion and contraction of piping, including loops, pipe offsets, expansion joints, and swing joints; as specified and as required.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.
- E. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so that movement takes place along axis of pipe only.
- F. Flexible piping shall not be used in concealed spaces. Access panel shall be provided for concealed space installation.

- G. Coordinate with installation of piping seismic braces so they do not interfere with thermal expansion loop action or building joint loop action.

**END OF SECTION**

**SECTION 22 05 19**  
**METERS AND GAUGES FOR PLUMBING PIPING**

**PART 1 – GENERAL****1.01 DESCRIPTION**

- A. This Section describes the requirements for water meters and gages primarily used for troubleshooting the system and to indicate system performance.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 00 – Common Results for Plumbing.

**1.02 RELATED WORK**

- A. Section 00 72 00 – General Conditions
- B. Section 01 33 00 – Submittal Procedures
- C. Section 22 05 00 – Common Results for Plumbing

**1.03 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - 1. B40.100-2013 – Pressure Gauges and Gauge Attachments
  - 2. B40.200-2008 – Thermometers, Direct Reading and Remote Reading
- C. American Water Works Association (AWWA):
  - 1. C700-2009 – Standard for Cold Water Meters, Displacement Type, Bronze Main Case
  - 2. C706-2010 – Direct-Reading, Remote-Registration Systems for Cold-Water Meters
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. C2–2012 – National Electrical Safety Code (NESC)
- E. International Code Council (ICC):

1. IPC-2021 – International Plumbing Code
- F. National Fire Protection Association (NFPA):
1. 70–2020 – National Electrical Code (NEC)
- G. NSF International (NSF):
1. 61-2021 – Drinking Water System Components – Health Effects
  2. 372-2021 – Drinking Water System Components – Lead Content

#### **1.04 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.
- B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 22 05 19 – METERS AND GAUGES FOR PLUMBING PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Water Meter.
  2. Pressure Gages.
  3. Thermometers.
  4. Product certificates for each type of meter and gage.
- D. Operations and Maintenance manual shall include:
1. System Description.
  2. Major assembly block diagrams.
  3. Troubleshooting and preventive maintenance guidelines.
  4. Spare parts information.
- E. Shop Drawings shall include the following: One line, wiring and terminal diagrams including terminals identified, protocol or communication modules, and Ethernet connections.

### **1.05 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit copies of complete operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three-ring binder per the requirements of Section 01 33 00 – Submittal Procedures. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

## **PART 2 – PRODUCTS**

### **2.01 DISPLACEMENT WATER METER**

- A. For pipe sizes 50 mm (2 inches) and smaller, the water meter shall be displacement type, full size nutating disc, magnetic drive, sealed register, and fully conform to AWWA C700. Peak domestic flow shall be 2.2 L/s (34 gpm). The meter register shall indicate flow in liters (U.S. gallons).
- B. The water meter shall be rated for use at temperatures ranging from -40 degrees C (-40 degrees F) and 70 degrees C (158 degrees F) and operate at a working pressure of 1035 kPa (150 psig).
- C. The meter case, bottom caps, and register box lids shall be constructed from cast bronze.
- D. The meter shall register plus or minus 3 percent of the water actually passing through it at any rate of flow within the normal test flow limits specified in AWWA 700.
- E. The water meter shall conform to NSF 61 and NSF 372.

### **2.02 WATER METER STRAINER**

- A. All meters shall be fitted with a factory installed integral strainer or bronze inlet strainer with top access. The strainer shall conform to AWWA C702.
- B. The water meter strainer shall conform to NSF 61 and NSF 372.

### **2.03 REMOTE READOUT REGISTER**

- A. All meters shall be equipped with a remote readout register in accordance with AWWA C706.

### **2.04 PRESSURE GAGES FOR WATER USAGE**

- A. ASME B40.100 all metal case 115 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 1380 kPa (0 to 200 psig) gage.
- B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.
- C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psig.
- D. The pointer shall be dark colored metal.
- E. The window shall be glass.
- F. The ring shall be brass or stainless steel.
- G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.
- H. The pressure gage for water domestic use shall conform to NSF 61 and NSF 372.

### **2.05 THERMOMETERS**

- A. Thermometers shall be straight stem, metal case, red liquid-filled thermometer, approximately 175 mm (7 inches) high, 4 degrees C to 100 degrees C (40 degrees F to 212 degrees F). Thermometers shall comply with ASME B40.200.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Direct mounted pressure gages shall be installed in piping tees with pressure gage located on pipe at the most readable position.
- B. Valves and snubbers shall be installed in piping for each pressure gage.
- C. Test plugs shall be installed on the inlet and outlet pipes of all heat exchangers or water heaters serving more than one plumbing fixture.

- D. Pressure gages shall be installed where indicated on the drawings and at the following locations:
  - 1. Inlet and outlet of each pressure reducing valve.
- E. Water meter installation shall conform to AWWA C700, AWWA C701, and AWWA C702. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. New materials shall be provided.
- F. Remote readout register shall be mounted at the location indicated on the drawings or as directed by the Owner's Representative.
- G. If an installation is unsatisfactory to the Owner's Representative, the Contractor shall correct the installation at no cost to the Owner.

### **3.02 FIELD QUALITY CONTROL**

- A. The meter assembly shall be visually inspected and operationally tested. The correct multiplier placement on the face of the meter shall be verified.

### **3.03 TRAINING**

- A. A training course shall be provided to the medical center on meter configuration and maintenance. Training manuals shall be supplied for all attendees with four additional copies supplied. The training course shall cover meter configuration, troubleshooting, and diagnostic procedures.

**END OF SECTION**

**SECTION 22 05 23  
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 00, SUBMITTAL PROCEDURES.
- C. Section 22 05 00, COMMON WORK RESULTS FOR PLUMBING.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications will govern.
- B. American Society of Mechanical Engineers (ASME):
  - A112.14.1-2003 .....Backwater Valves
- C. American Society of Sanitary Engineering (ASSE):
  - 1001-2021 .....Performance Requirements for Atmospheric Type Vacuum Breakers
  - 1003-2020 .....Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems
  - 1011-2020 .....Performance Requirements for Hose Connection Vacuum Breakers
  - 1013-2021 .....Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
  - 1015-2021 .....Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies
  - 1017-2009 .....Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems



- 1020-2020 .....Performance Requirements for Pressure Vacuum Breaker Assembly
- 1035-2020 .....Performance Requirements for Laboratory Faucet Backflow Preventers
- 1069-2020 .....Performance Requirements for Automatic Temperature Control Mixing Valves
- 1070-2015 .....Performance Requirements for Water Temperature Limiting Devices
- 1071-2012 .....Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
- D. American Society for Testing and Materials (ASTM):
  - A126-2004(R2019) .....Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
  - A276/A276M-2017 .....Standard Specification for Stainless Steel Bars and Shapes
  - A536-2014 .....Standard Specification for Ductile Iron Castings
  - B62-2017 .....Standard Specification for Composition Bronze or Ounce Metal Castings
  - B584-2014 .....Standard Specification for Copper Alloy Sand Castings for General Applications
- E. International Code Council (ICC):
  - IPC-2021 .....International Plumbing Code
- F. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
  - SP-25-2018 .....Standard Marking Systems for Valves, Fittings, Flanges and Unions
  - SP-67-2017 .....Butterfly Valves
  - SP-70-2011 .....Gray Iron Gate Valves, Flanged and Threaded Ends
  - SP-71-2018 .....Gray Iron Swing Check Valves, Flanged and Threaded Ends
  - SP-80-2019 .....Bronze Gate, Globe, Angle, and Check Valves
  - SP-85-2011 .....Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
  - SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

- G. National Environmental Balancing Bureau (NEBB):  
 8th Edition 2015                      Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- H. NSF International (NSF):  
 61-2020 .....Drinking Water System Components – Health Effects  
 372-2020 .....Drinking Water System Components – Lead Content
- I. University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCCHR):  
 10th Edition.....Manual of Cross-Connection Control

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.
- B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Ball Valves.
  - 2. Gate Valves.
  - 3. Check Valves.
  - 4. Water Pressure Reducing Valves and Connections.
  - 5. Backflow Preventers.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
  - 4. Piping diagrams of thermostatic mixing valves to be installed.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Valves shall be prepared for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.
  3. Set ball and plug valves open to minimize exposure of functional surfaces.
- B. Valves shall be prepared for storage as follows:
1. Maintain valve end protection.
  2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

## **1.6 AS BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" of Section 22 05 00, COMMON WORK RESULTS FOR PLUMBING.

## **PART 2 - PRODUCTS**

### **2.1 VALVES, GENERAL**

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing greater than 15 percent zinc shall not be permitted.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 m (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- E. All valves used to supply potable water shall meet the requirements of NSF 61 and NSF 372.

### **2.2 SHUT-OFF VALVES**

- A. Cold, Hot and Re-circulating Hot Water:
1. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be non-lead solder.

## 2.3 CHECK VALVES

- A. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.
- B. 100 mm or DN100 (4 inches) and greater:
  - 1. Check valves shall be Class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A126, bolted bonnet, flanged ends, bronze trim.
  - 2. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

## 2.4 WATER PRESSURE REDUCING VALVE AND CONNECTIONS

- A. 75 mm or DN75 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The pressure reducing valve shall meet ASSE 1003. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.
- B. The regulator shall have a tap for pressure gauge.
- C. The regulator shall have a temperature rating of 100 degrees C (212 degrees F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9 kPa (+/- 1 psig).
- D. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- E. Connections Valves and Strainers: Shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gauge shall be installed on the inlet and outlet of the valve.

## 2.5 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCC).
- B. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y positive-seal resilient gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276/A276M. The seat disc shall be the elastomer type suited for water service. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet. Reduced pressure backflow preventers shall be installed in the following applications.
1. Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.
  2. Water service entrance from loop system.
  3. Process equipment.
  4. Reclaimed water systems.
- C. The pipe applied or integral atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be cast bronze. The seat disc shall be the elastomer type suited for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable. Atmospheric vacuum breakers shall be installed in the following applications.
1. Hose bibs and sinks with threaded outlets.
- D. The hose connection vacuum breaker shall be ASSE listed 1011. The main body shall be cast brass with stainless steel working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of

portable hoses to hose thread outlets. Hose connection vacuum breakers shall be installed in the following locations requiring non-continuous pressure:

1. Hose bibbs and wall hydrants.
- E. The pressure vacuum breaker shall be ASSE listed 1020. The main body shall be brass. The disc and O-ring seal shall be the elastomer type. The valve seat and disc float shall be the thermoplastic type. Tee handle or lever handle shut-off ball valves. Test cocks for testing and draining where freezing conditions occur. All materials shall be suitable for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable. Pressure vacuum breakers shall be installed in the following locations requiring continuous pressure and no backpressure including equipment with submerged inlet connections:
1. 1. Lawn Irrigation.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.2 INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.

- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that shall be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.
  - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are prohibited for this application.
- F. Install pressure gauges on outlet of backflow preventers.
- G. Do not install bypass piping around backflow preventers.
- H. If an installation is unsatisfactory to the Owner's Representative, the Contractor shall correct the installation at no additional cost or time to the Owner.

### **3.3 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.
- B. Set field-adjustable flow set points of balancing valves and record data. Ensure recorded data represents actual measured or observed conditions. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- C. Testing and adjusting of balancing valves shall be performed by an independent NEBB Accredited Test and Balance Contractor. A final settings and flow report shall be submitted to the Owner's Representative.

### **3.4 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.

**E N D OF SECTION**

**SECTION 22 05 29**  
**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Pipe, duct, and equipment hangers and supports.
2. Anchors, equipment bases and supports.
3. Sleeves and seals.
4. Flashing, counter flashing and pipe stacks.
5. Firestopping.

C. Related Sections:

1. Section 00 72 00 – General Conditions.
2. Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.
3. Division 03 Section – Concrete.
4. Section 03 11 00 – Concrete Formwork.
5. Section 03 15 00 – Concrete Accessories.
6. Section 07 90 00 – Joint Fillers, Sealants and Caulking.
7. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment.
8. Section 22 07 19 – Plumbing Piping Insulation.



9. Section 22 11 13 – Facility Water Distribution Piping.

## 1.02 REFERENCES

### A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00 – General Conditions for the list of applicable regulatory requirements.
4. Refer to Section 22 05 00 – Common Results for Plumbing for codes and standards and other general requirements.

### B. Code of Federal Regulations 29 CFR 1910.7:

1. Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

### C. National Fire Protection Association (NFPA)

1. NFPA-13 Installation of Sprinkler Systems
2. NFPA-14 Installation of Standpipe and Hose Systems

### D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):

1. Seismic Restraint Manual: Guidelines for Mechanical Systems - latest edition for the support of ductwork.

### E. Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.

### F. UL Fire Resistance Directory, latest edition.

## 1.03 SUBMITTALS

- A. Submit under provisions of Section 22 05 00– Common Results for Plumbing - Review of Materials and Section 00 72 00 – General Conditions.
- B. Submit calculations showing compliance with Section 01 73 23 – Seismic Anchorage and Bracing, for piece of equipment whether supported or braced from above or below.

- C. Submit calculations showing compliance with Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.
- D. Submit shop drawing of hanger and support spacing, framing and attachment methods.
- E. Submit firestopping systems for every application.

## **PART 2 – PRODUCTS**

### **2.01 PIPE HANGERS AND SUPPORTS**

- A. Hangers for Pipe Sizes ½ (12.7 mm) to 1-1/2 Inch (38 mm): Stainless steel, adjustable swivel ring, UL listed, Grinnell Fig. 69 or equal. Use plastic coated hangers at all uninsulated copper piping.
- B. Hangers for Pipe Sizes 2 Inches (50.8 mm) and Cold Pipe Sizes 6 Inches (152.4 mm) and Over: Stainless steel, adjustable, clevis, UL listed, Grinnell Fig. 260 or equal.
- C. Trapeze Supports: 12 gauge channel complete with nuts, pipe clamps, pipe straps, and drive-in end caps. Furnish cushion strip on all uninsulated copper piping and; cast iron roll and stand for hot pipe sizes 6 inches and over.
- D. Pipe Supported Tight to Wall, Floor, or Ceiling: Superstrut A1200, Unistrut P1000, or equal, 12 gauge stainless steel channel complete with pipe clamps, nuts, bolts, and end caps. Furnish cushion strip on all uninsulated copper piping. and adjustable steel yoke and cast iron roll for hot-pipe sizes 6 inches and over.
- E. Vertical Support: Steel riser clamp, UL listed, Grinnell Fig. 261, Superstrut C720, or equal.
- F. Shield for Insulated Piping 2 Inches and Smaller: 18-gauge (1.31 mm) galvanized steel shield over insulation in 180 degree segments, at least 12 inches (300 mm) long at pipe support.
- G. Concrete Anchors: In accordance with Section 03 15 00 – Concrete Accessories.

### **2.02 DUCT SUPPORTS**

- A. See Section 23 31 13 – Metal Ducts and Ducts Accessories.

### **2.03 HANGER RODS**

- A. Stainless steel, threaded both ends, threaded one end, or continuously threaded.

## 2.04 ATTACHMENTS TO STRUCTURE

- A. Inserts for new formed concrete construction: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. For Suspension from New Formed Concrete Structure: Grinnell Figure 282, Superstrut 452, or equal, UL listed for the rod sizes, Grinnell, Fig. 282, Superstrut 452, or equal.
- B. Connection to Existing Concrete Structure: Hilti Kwik-Bolt, Phillips or equal, wedge type expansion anchors. Powder-driven fasteners may be used only for flexible duct, metal duct up to 16 inches (400 mm) round (or rectangular equivalent), and for air inlet and outlet wire seismic braces, and only within the parameters of the fastener's ICBO report. Provide current ICBO report. Do not use powder-driven fasteners for pipes or conduits.
- C. For Suspension from New Formed Concrete Structure: B-Line B3014, Grinnell Figure 282, Superstrut 452, or equal, adjustable concrete insert.
- D. For Support on New Concrete: Galvanized steel headed bolts.
- E. Welded Connection to Steel Beams: B-Line B3083, Grinnell, Superstrut, or equal, steel welded beam attachment.
- F. Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

## 2.05 SUPPORTS, BRACING, AND ACCESSORIES

- A. Miscellaneous Steel: Stainless Steel angles, channels, brackets, rods, clamps, etc., of new materials conforming to ASTM A36.
- B. Fasteners: Bolts and nuts, except as otherwise specified, shall conform to ASTM Standard Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. Bolts, washers, nuts, anchor bolts, screws and other hardware used outdoors or inside the penthouse shall be stainless steel, and stainless steel nuts shall have a free running fit. Provide bolts of ample size and strength for the purpose intended. Ferrous metal components below grade shall be stainless steel.
- C. Sheet Metal Screws: Plated, size 10 minimum.
- D. Pre-engineered duct and pipe bracing systems may be Mason Industries Seismic Sway Brace System or equal.

## 2.06 COUNTER FLASHING

- A. Metal Flashing: 26-gauge galvanized steel.

10/17/2024

- B. Flexible Flashing: 47-mil thick sheet butyl; compatible with roofing.
- C. Caps: Steel, 16 gauge.

## **2.07 EQUIPMENT CURBS**

- A. See Architectural and Structural Drawings for the design detail of the equipment curb.

## **2.08 SLEEVES**

- A. Adjust-To-Crete, AMI Products, or equal, 24 gauge, electro-galvanized adjustable sleeve, up to 6" diameter. For 8 inches (200 mm) and larger, provide galvanized standard weight steel pipe sleeves
- B. Sleeves for Round Ductwork: Form with galvanized steel.
- C. Sleeves for Rectangular Ductwork: Form with galvanized steel or wood.
- D. Caulk: Acrylic sealant of quality specified in Section 07 90 00 – Joint Fillers, Sealants and Caulking.

## **2.09 FABRICATION**

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers for installation without disengagement of supported pipe.

## **2.10 FINISH**

- A. Mil finish for stainless steel hangers and supports

## **PART 3 – EXECUTION**

### **3.01 ATTACHMENTS TO STRUCTURE**

- A. Concrete Structure: Locate anchors from Edge condition and at a spacing to obtain maximum working loads specified in the applicable ICC report.
  - 1. See structural drawings for additional restrictions for locating anchors.
- B. Steel Structure: Attach at beam axis. Avoid eccentric loads wherever possible.
- C. Rating: Ultimate strength at least five times the imposed load.
- D. Submit for structural review pipe hanger locations, point loads and structural attachment details for pipes 6" and larger.

- E. Coordinate installation so that attachments to structure are made prior to fireproofing. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary. Fireproofing material shall match existing.
- F. Where point loads, imposed by work of Division 22, are greater than can safely be carried by the roof or deck, provide structural steel spreader beams tied to the building structure. Submit details of such spreader beams for approval.
- G. Inserts:
  - 1. Furnish inserts to Division 03 Sections – Concrete and Concrete Forming for placement in concrete form work.
  - 2. Furnish inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Furnish hooked rod to Division 03 Sections – Concrete and Concrete Forming for inserts carrying pipe larger than 4 inches (100 mm).
  - 4. Where concrete slabs form finished ceiling, furnish inserts to be flush with slab surface.
  - 5. Where inserts are omitted, submit an attachment plan to the Owner's Representative.

### **3.02 SUPPORTS, BRACING, AND ACCESSORIES**

- A. Common support systems: This Section is responsible for the provision, coordination, calculations, and seismic bracing of support systems common to Division 22 work. Individual section shall provide their own horizontal support struts. Division 22 shall coordinate with other divisions of all aspects of hanger installation, horizontal strut installation, pipe/conduit/cable tray/etc. installation, seismic bracing installation, and so on.
- B. Set machines and devices dead level, except where pitch or slope is specified or shown. Securely fasten to the structure unless shown otherwise. Use dry pack cement grout to obtain complete contact between structure and equipment.
- C. This Section is responsible for the concrete work for the support of equipment provided by this Section. Coordinate locations with anchor bolts before concrete is placed.
- D. Pipe Hangers and Supports:
  - 1. Support horizontal piping as follows:

Pipe Size	Maximum Hanger Spacing	Hanger Diameter
1/2 to 1-1/4 inch (12.7 to 31.75 mm)	6 feet 6 inches (2 m)	3/8 inch (9.5 mm)
1-1/2 to 2-inch (38.1 to 50.8 mm)	10 feet (3 m)	3/8 inch (9.5 mm)
2-1/2 to 3-inch (63.5 to 76.2 mm)	10 feet (3 m)	1/2 inch (12.7 mm)
PVC (All sizes)	6 feet (1.8 m)	3/8 inch (9.5 mm)
C.I. Bell and Spigot (or No-Hub)	5 feet (1.5 m) at joints	3/8 inch (9.5 mm)

2. Install hangers to provide at least 1/2 inch (13 mm) space between finished covering and adjacent work.
3. Place a hanger within 12 inches (300 mm) of each horizontal elbow.
4. Use hangers with at least 1-1/2 inch (38 mm) vertical adjustment.
5. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
6. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Use specified pipe shields (if applicable). Trapeze size, and support size and spacing shall be governed by the cumulative weight of the supported piping. Maximum trapeze deflection shall be 1/240th of the span on a maximum stress of 15,000 psi (103.5 MPa), whichever is more stringent.
8. Support riser piping independently of connected horizontal piping.
9. Brace piping longitudinally and transversely as specified and indicated on the drawings. Design of the seismic bracing shall be in accordance with Section 01 73 23 – Seismic Anchorage and Bracing.
10. Support pipe from the building structure so that there is no apparent deflection in pipe runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Do not support from, or brace to, ducts, other pipes, conduit, or materials except building structure. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape, plastic ties, or blocking of any kind. Vertical piping running between floors shall be additionally supported at mid points in a rigid and immobile fashion. Exposed or concealed piping which can be physically moved, and which is not properly supported will not be accepted, and additional support or bracing

will be required. Install seismic bracing as at locations as specified in the contract drawings.

11. Install and secure equipment with anchors and braces to floors, structural members and walls with sufficient backing, to prevent vibration and/or horizontal displacement under load and seismic force as hereinbefore specified. Follow manufacturer's recommendations for the installation of vibration isolators where required for equipment requiring such.

E. Equipment Bases and Supports:

1. Comply with Division 03 Sections – Concrete and Concrete Forming for concrete bases.
2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
3. Construct support of steel members. Brace and fasten with flanges bolted to structure. Level equipment installed on steel rails using shims to compensate for the deflection of the steel.
4. Provide rigid anchors for pipes after vibration-isolation components are installed.

F. Counter Flashing:

1. See Architectural Drawings for flashings.
2. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
3. Counterflash vent and soil pipes projecting at least 3 inches (75 mm) above finished roof surface with lead worked at least 1 inch (25 mm) into hub, at least 8 inches (200 mm) clear on sides using 24 inches (600 mm) by 24 inches (600 mm) sheets. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
4. Counterflash floor drains in floors with topping over finished areas with lead, 10 inches (250 mm) clear on sides using at least 36 inches by (900 mm) 36 inches (900 mm) sheets. Fasten flashing to drain clamp device.
5. Seal floor, shower, mop sink, and drains watertight to adjacent materials.
6. Provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

7. Provide curbs for mechanical roof installations at least 14 inches (350 mm) high above roofing surface. Counterflash with flexible sheet and counterflash with sheet metal; seal watertight.

G. Sleeves:

1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves full depth and provide floor plate.
3. Where piping or ductwork penetrates floor, ceiling, or wall, close-off space between pipe or duct and adjacent work with fire-stopping insulation and caulk airtight. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
4. Install chrome-plated steel escutcheons at finished surfaces.

### 3.03 SEISMIC RESTRAINTS

- A. Provide support hanger system, equipment, ductwork and piping with seismic restraints in accordance with Section 01 73 23 – Seismic Anchorage and Bracing.
- B. Pipe seismic restraints shall not interfere with pipe thermal expansion loop action or pipe building joint expansion loop action.

**END OF SECTION**



**SECTION 22 05 48**

**VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Inertia bases
2. Vibration isolation.

C. Related Sections:

1. Section 00 72 00 – General Conditions.
2. This section requirements apply to Division 22 Sections.

**1.02 REFERENCES**

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00– General Conditions for the list of applicable regulatory requirements.
4. Refer to Section 22 05 00 – Common Results for Plumbing for codes and standards, vibration and noise, and other general requirements.

### 1.03 SUBMITTALS

- A. Submit under provisions of Section 22 05 00 – Common Results for Plumbing - Review of Materials and Section 00 72 00 – General Conditions.
- B. Product Data:
  - 1. Provide specific information for items described under the products section of this Specification, including specifications, descriptive drawings, catalog cuts, and descriptive literature, including make, model, dimensions, weight and interface description with other work, and indicating full compliance with specifications as outlined.
  - 2. An itemized list showing items to be isolated, the isolator type, model number, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable.
- C. Shop Drawings:
  - 1. Indicate inertia bases and vibration isolator locations, with static and dynamic load on each.
  - 2. Drawings showing intended locations.
  - 3. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, and support point locations.
  - 4. Drawings showing methods for suspension, of support, and guides.
  - 5. Drawings showing methods for isolation of piping, at penetrations of walls, slabs, etc.
- D. Maintenance and Operations Data: Submit manufacturer's certificate that isolators are installed and adjusted to meet or exceed specified requirements.

### 1.04 QUALITY ASSURANCE

- A. Maintain ASHRAE criteria for average noise criteria curves for equipment at full-load condition

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Mason, M.W. Sausse, Isolation equipment shall be supplied by a single manufacturer. Model numbers given below are Mason's. Vibration isolation components (isolators, snubbers, rails, and inertia bases) to be hot-dip galvanized. Welded steel channel

perimeter frame with welded-in reinforcing bars, prelocated welded-in anchor bolts or prelocated bolt holes suitable for the number and size required, and height saving brackets where required. Inertia bases shall be 1.5 times of the weight of the equipment. Snubbers shall be provided. Delete inertia base requirement if the equipment is provided with motor rating of less than 15 hp and is provided with steel frame base.

- B. Type "A" Support from Below with Spring Isolators: Model SSLFH captive spring mount for seismic and restrained service with leveling bolts, corrosion resistant finish, and 1/4 inches (6 mm) ribbed neoprene base pad. Provide optional baseplate with bolt holes where required. Furnish vibration isolation products from a single manufacturer. The only exception is internal vibration isolation that is integral with the equipment, such as internal isolators on air handling units.
- C. All vibration isolation components (isolators, snubbers, rails, and inertia bases) to be hot-dip galvanized.

## 2.02 VIBRATION ISOLATORS

### A. General:

- 1. Metal parts of vibration-isolation units shall be as follows:
  - a. Housing: Hot-dipped galvanized outdoors, and inside air handlers and painted indoors. Galvanizing shall meet ASTM Salt Spray test Standards and Federal Test Standard no. 14.
  - b. Hardware (washers, nuts, bolts, etc.): Galvanized outdoors, and inside air handlers, and cadmium plated indoors.
  - c. Springs: Neoprene coated outdoors, inside air handlers, and painted indoors.
- 2. Isolator types are scheduled to establish minimum standards. At the Subcontractor's option, accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevation during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade the vibration isolation system.
- 3. Static deflection of isolators are indicated in Vibration Isolation Schedule. Static deflections stated are the minimum acceptable deflection for the mounts under actual load.
- 4. The use of nested springs or of multiple parallel springs within a single mount is not permitted.

### B. Unit HS (Hanger Spring):

1. Vibration-isolation hangers shall consist of a free-standing laterally stable steel spring set into a neoprene cup, contained within a steel housing. The neoprene cup shall be manufactured with a grommet (or other element) to prevent the hanger rod from contacting the hanger housing. A steel washer shall be provided in the neoprene cup to evenly distribute load onto the neoprene.
2. The plate or washer at the top of the spring shall be welded to the spring. The hanger rod shall be securely fastened to this plate or washer using lock nuts. The hanger rod shall have a diameter not less than 5/8 inch. This design represents a modification to the unit types given below. The modification is intended to limit the side-to-side motion of the hanger rod relative to the hanger casing.
3. Spring diameter and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the housing. Spring elements shall have minimum additional travel to solid equal to 50 percent of the actual deflection.
4. Upper hanger rod attachment shall be made through a neoprene rubber-in-shear element designed to avoid direct contact between the hanger rod and the isolator frame.
5. Springs shall be color coded for ease of identification and removable, for field connection.
6. Unit HS isolators shall be one of the following products or equal:
  - a. Type 30N (modified): M.I.
  - b. Type SH (modified): K.N.C.
  - c. Type RSH (modified): V.M.C.

### **2.03 SNUBBERS**

- A. Snubbers to limit the vertical and horizontal motion of the isolated equipment shall be fabricated from steel. A neoprene pad, 1/4-inch minimum thickness, shall be affixed at the point of contact. There will be no contact between snubbers and the inertia base or equipment support frame during normal operation. Minimum of one snubber per side, four total, shall be required on each base. Seismic snubbers shall have a minimum of 1.0G ratings and anchorages.
- B. Snubbers shall not be finally installed until vibration isolators are in place and adjusted with actual operating loads.
- C. Model Z-1225 for installations within the maximum seismic load requirements consistent with the manufacturer's recommendations, and Model Z-1011 for greater seismic load requirements, manufactured by M.I., Model HS-4 manufactured by K.N.C., or equal.

## 2.04 PIPING ISOLATORS

- A. Specialty Products Co. Acousto-Plumb isolators for pipe  $\frac{3}{4}$  inch (20 mm) and smaller, and Trisolator for pipes 1 inch (25 mm) and larger, or equal.

## PART 3 – EXECUTION

### 3.01 GENERAL

- A. The Subcontractor is to obtain inspection of installation to be covered or enclosed prior to such closure.
- B. The Subcontractor is to obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices.
- C. The Subcontractor is to correct, at no additional cost, installations which are deemed defective in workmanship or materials.
- D. The Subcontractor is responsible for proper operation of systems, minor sub-systems, and services provided under this Section. The Subcontractor is to coordinate startup procedures, calibration, and system check-out with Subcontractors involved. Any system operational problems shall be diagnosed. Correctional procedures shall be initiated by the various Subcontractors as required to bring the system into compliance with the design, and the problem shall then be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the Owner.
- E. Do not install equipment, ductwork, piping and conduit which makes rigid contact with the structure unless it is allowed by this specification.
- F. The Subcontractor is to bring to the Owner's attention prior to installation conflicts which will result in unavoidable contact between the building structure and the isolated equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation is at the expense of the Subcontractor.
- G. The Subcontractor is to bring to the Owner's attention prior to installation discrepancies between the requirements of this Specification and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation is at the expense of the responsible Subcontractor.
- H. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for piping, conduit, ductwork, etc. supported on Type HS or Type FSN isolators. Refer to resilient penetration details on the Drawings.
- I. Support vibration isolated ducts, pipes, and equipment directly from structural steel, not the concrete deck.

### 3.02 ISOLATOR INSTALLATION

- A. The installation or use of vibration isolators must not cause change of position of equipment, conduit, piping or ducting, which would result in stresses in connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and attached systems in a rigid position during installation, the load shall not be transferred to the isolator until the installation is complete and under full operational load. plumbing, piping, and ducting at mechanical equipment connections is to be fully supported by specified hangers. Mechanical equipment and vibration mounts shall not carry plumbing, piping, or ducting loads. Utilize flexible metal, liquid-tight conduit for electrical connections.
- B. Isolation/Absorption Products: The completed installation must be free of vibration and noise. Systems, equipment, or parts which vibrate or generate vibration unduly, or which generate or emit undue noise while in operation shall: 1) be adjusted, repaired or replaced as appropriate to obtain acceptable levels of vibration or noise; or 2) be supported on, or fitted with, suppression or absorption devices or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.
- C. Equipment Isolator Installation:
1. Use space saver brackets for equipment supported on Type FSN vibration isolators.
  2. The minimum operating clearance between the underside of the frame or inertia base and the pad or floor is 1 inch.
  3. Place the frame in position and support temporarily by shims prior to the installation of the machine or isolators.
  4. After the entire system installation is completed and under full operational load, adjust the isolators so that the load is transferred from the shims to the isolators, and that the shims are barely free. Remove the shims.
  5. Seismic snubbers shall not be finally installed until vibration isolators are in-place and adjusted with actual operating loads.
- D. Isolator Hangers:
1. The isolators shall be installed with the isolator hanger box as close as possible to the structure.
  2. The isolators shall be suspended from massive beams, never from slab diaphragms between beams.
  3. Orientation of isolator assembly including support and load rods shall be within five degrees of vertical.

**3.03 EQUIPMENT ISOLATION**

- A. Install isolators for fans, chillers, compressors, pumps and other such equipment as shown on Vibration Isolation Schedule or as otherwise required.
- B. Approve completed vibration isolation system for isolated equipment.

**3.04 PIPING ISOLATION**

- A. Where specifically indicated only, use specified pipe isolation system.

**3.05 VIBRATION ISOLATION SCHEDULE**

Equipment	Base Type and Weight <sup>1</sup>	Isolator Type	Minimum Static Deflector (inches)
Pipes with water pressure (ICW, IHW, DIWS, DIWR, TRWS, TRWR, HHWS, HHWR) in rooms XXX (list rooms).	NA	Acousto-Plumb and insulate pipes at each partition penetration with one-inch thick insulation	NA

11X = 1 time the weight of the equipment supported.  
 2X = 2 times the weight of the equipment supported.  
 NA = Not applicable

**END OF SECTION**

**SECTION 22 05 53**  
**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 – GENERAL****1.01 SUMMARY**

## A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

## B. Section Includes:

1. Identify all installed mechanical distribution piping, mechanical equipment and components.
2. Cast-in-place concrete.

## C. Related Sections:

1. Section 00 72 00 – General Conditions
2. Section 09 90 00 – Painting for identification painting

**1.02 REFERENCES**

## A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00 – General Conditions for the list of applicable regulatory requirements.
4. Refer to Section 22 05 00 – Common Results for Plumbing for codes and standards, and other general requirements.

## B. ASME –American Society of Mechanical Engineers:



1. ASME A 13.1 – Scheme for the identification of piping systems

**1.03 SUBMITTALS**

1. Submit under provisions of Section 22 05 00 – Common Results for Plumbing, Review of Materials and Section 00 72 00 – General Conditions.
- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

**PART 2 – PRODUCTS**

**2.01 ACCEPTABLE MANUFACTURERS**

- A. W. H. Brady or Westline products.
- B. No substitutions.

**2.02 MATERIALS**

- A. Color coding: ASME A13.1 unless specified otherwise.
- B. Plastic nameplates: laminated two-layer plastic with engraved black letters on light, contrasting background color.
- C. Plastic tags: laminated three-layer (double-sided) plastic with engraved black letters on light, contrasting background color. Tag size at least 1-1/2 inch (38 mm) diameter.
- D. Stencils: with clean-cut symbols and letters of following size:

Outside Diameter of Insulation or Pipe	Color Field Length	Letter Height
¾ to 1-1/4 inches (9.5 to 31.7 mm)	8 inches (200 mm)	½ inch (13 mm)
1-1/2 to 2 inches (38.1 to 50.8 mm)	8 inches (200 mm)	¾ inch (20 mm)
2-1/2 to 2 inches (63.5 to 50.8 mm)	12 inches (300 mm)	1 ¼ inch (32 mm)

- E. Stencil paint: semi-gloss enamel; in accordance with Section 09 90 00 – Painting.
- F. Plastic pipe markers: factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

1. Special gases shall be identified using markers with yellow background and black letters, direction arrow, and full chemical names and symbols.
- G. Plastic-tape pipe markers: flexible, vinyl-film tape with pressure-sensitive adhesive backing and printed markings.

## **PART 3 – EXECUTION**

### **3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive of identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 – Painting for stencil painting.

### **3.02 INSTALLATION**

- A. Plastic nameplates: install with corrosion-resistant mechanical fasteners, or adhesive.
- B. Plastic tags: install with corrosion-resistant chain.
- C. Stencil painting: apply in accordance with Section 09 90 00 – Painting.
- D. Plastic pipe markers: install in accordance with manufacturer's instructions.
- E. Plastic-tape pipe markers: install completely around pipe in accordance with manufacturer's instructions.
- F. Underground plastic pipe markers: install 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

### **3.03 IDENTIFICATION SCHEDULE**

- A. Equipment: identify air-handling units, pumps, heat-transfer equipment, tanks, and water-treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic tags.
- B. Controls: identify control panels and major control components outside of panels with plastic nameplates.
- C. Valves: identify valves in main and branch piping with tags.
- D. Piping: identify piping, concealed or exposed, with stenciled painting. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not more than 20 feet (6 m) apart on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- E. Ductwork: identify ductwork with stenciled painting. Identify as to air-handling unit number, and area served. Locate identification at air-handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

### **3.04 STENCILING AND IDENTIFICATION**

- A. Stencil each piece of new and existing equipment including pumps, fans, tanks, etc., with the equipment tags scheduled on the drawings. Use minimum 2 inches (50 mm) high characters.
  - 1. Stencil each duct leaving the mechanical room indicating fan unit, area(s), direction of flow, or room(s) served.
  - 2. Stencil each duct branch leaving an air shaft at each floor with fan number, and identify it as a supply, exhaust, or return duct, and indicate direction of air flow.
- B. Post a framed and typewritten schedule of all stencils, pipe markers, valve tags, and lubricants used, with identification, shall be framed and posted in the mechanical equipment room.
- C. Identify all pipes with specified markers.
  - 1. Install markers every 10 feet (3 m) on mains, at all branch take-offs and adjacent to valves and cocks.
  - 2. Apply to all exposed pipes, pipes behind removable tile ceiling, pipes in concealed but accessible locations, such as behind access panels and at least once in each room.
  - 3. Install pipe marker using pressure sensitive adhesive in accordance with the manufacturer's directions. The marker shall completely cover the circumference of the pipe and overlap itself.
- D. Valve Tags: Provide numbered tags for main valves, branch valves, zone valves, shut-off valves, and balancing valves installed under this Contract, constructed of #18 gauge (1.02 mm) brass, circular, 1 ¼ inches (31.7 mm) in diameter, and with numbers cut in and blackened so as to be plainly discernible. Fasten tags to valve with brass links.
  - 1. Valve numbers not required for valves obviously serving equipment such as air handler coils, reheat coil valves, and miscellaneous drains.
  - 2. On the as-built drawings, indicate the location and number of each tagged valve.
  - 3. Provide a computer file database in a form agreeable to the Owner, describing the valve, number, location, type of service normally "open" or "closed", specific duty of each tagged valve, and manufacturer and model number.

- E. Warning Sign at Fume Exhaust Plenums: Place warning sign on each fume exhaust plenum access - "WARNING. HAZARDOUS ATMOSPHERE INSIDE. USE BREATHING APPARATUS" when breaching containment.
- F. Place warning signs on all machines driven by electric motors which are controlled by fully automatic starters.
- G. Fire dampers and fire smoke dampers: at each fire damper or fire smoke damper access panel, label "FIRE DAMPER" or "FIRE SMOKE DAMPER" in minimum 2 inches (25 mm) high letters. Fire smoke dampers shall be provided with tags to identify each fire smoke dampers as "FSD-NUMBER SEQUENCES-BLDG NUMBER". Provide chart to the Owner's Representative for approval.
- H. Wherever charts, Shop Drawings, etc. refer to specific room numbers, use room numbers that will be provided by the Owner rather than the room numbers indicated on the Drawings.

**END OF SECTION**

**SECTION 22 07 19**  
**PLUMBING PIPING INSULATION**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Related Documents: Drawings and general provisions of the Subcontract apply to this Section.
1. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
1. Piping insulation.
  2. Jackets and accessories.
- C. Related Sections:
1. Section 00 72 00 – General Conditions
  2. Section 09 90 00 – Painting for painting insulation jacket.
  3. Section 22 05 3 – Identification for Plumbing Piping and Equipment.

**1.02 REFERENCES**

- A. General:
1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
  2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
  3. Refer to Section 00 72 00 – General Conditions for the list of applicable regulatory requirements.
  4. Refer to Section 22 05 00 – Common Results for Plumbing for codes and standards, and other general requirements.
- B. ASTM International:

1. ASTM-B-209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  2. ASTM-C-195 – Standard Specification for Mineral Fiber Thermal Insulating Cement
  3. ASTM C534 / C534M – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  4. ASTM-C-578– Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
  5. ASTM-E-84 – Standard Test Method for Surface Burning Characteristics of Building Material.
  6. ASTM C 450 – Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
  7. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
  8. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  9. ASTM A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- C. Code of Federal Regulations 20-CFR-1910.7 Definitions and Requirements for A Nationally Recognized Testing Laboratory (NRTL)
- D. National Fire Protection Association NFPA-90A & NFPA-255 Surface Burning Characteristics of Building Materials
- E. Underwriters Laboratories UL-723 Surface Burning Characteristics of Building Materials

### **1.03 SUBMITTALS**

- A. Submit under provisions of Section 22 05 00 – Common Results for Plumbing, Review of Materials and Section 00 72 00 – General Conditions.
- B. Subcontractor shall submit the product description, list of materials and thickness for each service, and at each location.

### **1.04 QUALITY ASSURANCE**

- A. Subcontractor shall assure applicator is a company specializing in piping insulation application with at least 3 years of relevant experience.

- B. Fire Hazard: Provide insulation, jackets, facings adhesives and accessories acceptable to the State Fire Marshall and meeting the requirements of NFPA 90A. Meet the following hazard classifications stated in accordance with U.L. Test Method of Fire Hazard - Classifications of Building Materials, No. 723:
1. Flame-spread: Maximum 25.
  2. Fuel Contributed: Maximum 50.
  3. Smoke Developed: Maximum 50.

## **PART 2 – PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Imcoa
- B. Rubatex.
- C. Armacell (Armaflex Cellular Insulation) LLC.
- D. No substitutions.

### **2.02 INSULATION MATERIALS**

- A. Flexible Cellular Polyolefin Foam:
1. General: In accordance with ASTM C534.
  2. Insulation: Imcoa, Imcolock with pre-slit longitudinal seam with each mating surface adhesive coated and protected with a mylar release liner.
  3. No external vapor barrier jacket shall be required if the water vapor permeability is 0.01 perm inch or less. Insulation which is UV stabilized can be exposed to sunlight and weathering without any special paint coating. The insulation can be directly buried underground without any protective jacket if the manufacturer warrants its underground use.
  4. Description: Imcolock shall meet requirements of ASTM C534, UL94HBF, UBC42-1 Class I, ASTM E84 25/50, NFPA 255, UL723.
  5. K Factor: ASTM C177 0.24 at 75 Degrees F, 0.26 at 90 Degrees F
  6. Moisture Vapor Transmission: ASTM E96 (0.0) Zero Perm Inch
  7. Minimum Service Temperature: -110 Degrees F

8. Maximum Service Temperature: 210 Degrees F
  9. Maximum Flame Spread: ASTM E84 25
  10. Maximum Smoke Developed: ASTM E84 50
  11. Shall contain no potential corrosive constituents associated with stress corrosion failure of copper tubing.
  12. Connection Method Piping System Temperature Range
  13. Fuse-Seal Hot Melt Method -110 degrees +210 degrees
  14. Contact Adhesive (Mfg. Approval) -110 degrees +210 degrees
  15. Lap seal end joint tape recommended by insulation manufacturer  
32 degrees +210 degrees
- B. Elastomeric Foam Insulation: Rubatex R-180-FS tubing insulation been compounded to meet the indicated flame spread and smoke density rating.
1. Insulation thicknesses of 3/8, 1/2, and 3/4 inch, tested independently, shall have a maximum fire/smoke rating of 25/50. Other thicknesses are rated at 25/100.
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in performing insulation to cover valves, elbows, tees, and flanges.

### **2.03 FIELD-APPLIED JACKETS**

- A. General: ASTM C 921, Type I, unless otherwise indicated.
- B. Foil and Paper Jacket: Not acceptable.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
1. Adhesive: As recommended by insulation material manufacturer.
  2. PVC Jacket Color: White
  3. PVC Jacket Color: Color-code piping jacket as determined by existing conditions.
  4. Not to be used for outdoors.
- D. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil (0.75 mm) thick, high-impact, ultraviolet-resistant PVC.



1. Shapes: 45 and 90-degree, short and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
  2. Adhesive: As recommended by insulation material manufacturer.
  3. Not to be used for outdoors.
- E. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209 (ASTM B 209M), 3003 alloy, H-14 temper.
1. Finish and Thickness: Smooth finish, 0.010 (0.25 mm) inch thick.
  2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
  3. Elbows: preformed 45 and 90-degree, short and long-radius elbows; same material, finish, and thickness as jacket.

#### **2.04 ACCESSORIES AND ATTACHMENTS**

- A. Bands: stainless steel ASTM A666, Type 304, 3/4 inch (20 mm) wide; 0.02 inch (0.050 mm) thick.

#### **2.05 VAPOR RETARDANTS**

- A. Mastics: Use materials as recommended by the insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### **2.06 SEALANTS**

- A. Joint Sealants:
1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### **PART 3 – EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Install materials after piping has been tested and approved.
- B. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### **3.03 GENERAL APPLICATION REQUIREMENTS.**

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for material, form, jacket, and thickness required for each piping system insulation requirements.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften or otherwise attack insulation or jacket when in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retardant mastic on insulation indicated to receive a vapor retardant.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond the seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retardant integrity, unless otherwise indicated. Refer to special instruction for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retardant is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retardant mastic.
  - 1. Apply insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor retardants are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retardant integrity.
  3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation where vapor retardants are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retardant integrity.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
  2. Circumferential Joints: Cover with 3 inches (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4-inches o.c.
  3. Longitudinal Seams: Overlap jacket seams at least 1 1/2 inches (38 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4-inches o.c.
  4. Exception: Do not staple longitudinal laps on insulation having a vapor retardant.
  5. Vapor-retardant mastics: Where vapor retardants are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
  6. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retardant mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
1. Seal penetrations with vapor-retardant mastic.
  2. Apply insulation for exterior applications tightly joined to interior insulation ends.

3. Extend metal jacket for exterior insulation occurring outside of roof flashing at least 2-inches below the top of the roof flashing.
  4. Seal sheet metal jacket to roof flashing with vapor-retardant mastic.
- Q. Exterior Wall Penetrations: For penetration of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retardant mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions
1. Firestopping and fire-resistive joint sealers are specified in Division 07 "Penetration Firestopping".
  2. Floor Penetrations: Apply insulation continuously through floor assembly.
  3. For insulation with vapor retardants, seal insulation with vapor-retardant mastic where floor supports penetrate vapor retardant.

### **3.04 PREFORMED ELASTOMERIC CELLULAR THERMAL INSULATION APPLICATION**

- A. Apply insulation to straight pipes and tubes as follows:
1. Install pipe insulation by slitting tubular sections and applying onto pipes. Seams and butt joints shall be adhered and sealed using Armaflex 520 adhesive
  2. All edges shall be clean-cut. Rough or jagged edges shall not be permitted.
- B. Apply insulation to valves, flanges and fittings as follows:
1. Insulate with the same insulation thickness as the adjacent piping. Seams and butt joints shall be adhered and sealed with Armaflex 520 adhesive.
  2. All edges shall be clean-cut. Rough or jagged edges shall not be permitted.
- C. Outdoor insulation shall be protected as follows:
1. Furnish PVC jacket and PVC fitting covers or aluminum jackets.
  2. All jackets shall have the seams located on the bottom of the pipes.

### **3.05 FIELD-APPLIED JACKET APPLICATION**

- A. Apply PVC jacket where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

- B. Apply metal jacket where indicated, with 2-inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel band 12 inches (300 mm) o.c. and at end joints.
- C. Insulation and jacket for cold pipes shall include wicks to direct possible condensation to outside the jacket. The product shall be Knauf PermaWick or equal.
- D. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with or without vapor barrier, factory-applied or field-applied. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets shall be used.
- E. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with canvas jacket; size for finish painting. PVC jackets shall be used.
- F. Exterior Applications: Provide vapor-barrier jackets. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe and cover with aluminum jacket.
- G. Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt-impregnated open-mesh glass fabric, with 0.001 inch thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

### **3.06 FINISHES**

- A. Paint insulation as specified in Section 09 90 00 – Painting.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

### **3.07 PIPING SYSTEM APPLICATIONS**

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment.
  - 1. Flexible connectors.
  - 2. Vibration control devices.
  - 3. Fire-suppression piping.

4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Below-grade piping, unless otherwise indicated.
6. Chrome-plated pipes and fittings, unless potential for personal injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

### **3.08 INSULATION APPLICATION SCHEDULE, GENERAL.**

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

### **3.09 INTERIOR INSULATION APPLICATION SCHEDULE**

- A. Service: Domestic and Industrial cold and hot water. 203.2 mm
  1. Operating Temperature: 60 to 140 deg F (15.6 to 60 deg C).
  2. Insulation Material: Mineral-fiber
  3. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Copper Pipe, Up to 2 inches (50.8 mm): 1 inch (25 mm) Insulation
  4. Field-Applied Jacket: PVC
  5. Vapor Retarder Required: Yes
  6. Finish: As specified in Paragraph 3.06 of this Section.

### **3.10 EXTERIOR INSULATION APPLICATION SCHEDULE**

- A. This application schedule is for aboveground insulation outside the building.
- B. Service: Domestic, industrial Water.
  1. Operating Temperature: 60 to 140 deg F (15 to 60 deg C).
  2. Insulation Material: Mineral-fiber
  3. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Copper pipe, All sizes: 1 inch (25 mm) Insulation

- b. Polypropylene Pipe 1 inch (25 mm) Insulation
- 4. Field-Applied Jacket: Aluminum
- 5. Vapor Retarder Required: Yes
- 6. Finish: As specified in Paragraph 3.06 of this Section.

**END OF SECTION**

**SECTION 22 10 13  
FACILITY FUEL PIPING**

**PART 1 – GENERAL**

**1.01 SCOPE**

- A. This Section contains specifications for fuel pipe and fuel pipe fittings for this project.

**1.02 RELATED WORK**

- A. Section 01 75 00 – Checkout and Startup Procedures
- B. Section 22 11 19 – Domestic Water Piping Specialties
- C. Section 22 05 19 – Meters and Gauges for Plumbing Piping
- D. Section 22 11 13 – Facility Water Distribution Piping
- E. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
- F. Section 22 07 19 – Plumbing Piping Insulation

**1.03 REFERENCE**

- A. Applicable provisions of Division 01 govern work under this Section.
- B. Reference Standards:
  - 1. ANSI B1 – Malleable Iron Threaded Fittings
  - 2. ASTM A53 – Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
  - 3. ASTM A234 – Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
  - 4. ANSI B3 – Pipe Material Requirements

**1.04 QUALITY ASSURANCE**

- A. Substitution of Materials: Refer to Section 00 72 00 – General Conditions and Section 01 33 00 – Substitution Procedures.



**1.05 SHOP DRAWINGS**

- A. Refer to Section 01 33 00 – Submittal Procedures.
- B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

**1.06 TYPE E OR S STEEL PIPE:**

- A. Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

**1.07 QUALITY ASSURANCE**

- A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

**1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place.
- C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

**1.09 DESIGN CRITERIA**

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

- B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in occupied spaces and ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

#### **1.10 WELDER QUALIFICATIONS**

- A. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code and/or the National Certified Pipe Welding Bureau.
- B. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C. The Engineer reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.

#### **1.11 NATURAL GAS SERVICE**

- A. All charges for the gas service as shown on the plans, including the connection from the main in the street or other location to the gas meter, shall be paid by this Contractor, including setting of gas meter(s) and all work performed by the gas company.

### **PART 2 – PRODUCTS**

#### **2.01 NATURAL GAS**

- A. Type E or S pipe material is required per ANSI B31.9.

- B. 2" and Smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- C. 2-1/2" and Larger: ASTM A53, type E or S, standard weight black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

## **2.02 VENTS AND RELIEF VALVES**

- A. Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

## **2.03 UNIONS AND FLANGES**

- A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping iron on black steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

## **PART 3 – EXECUTION**

### **3.01 PREPARATION**

- A. Remove all foreign material from interior and exterior of pipe and fittings.

#### **B. ERECTION**

- 1. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

2. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
3. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
4. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
5. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
  - a. This requirement is based on NFPA 70-1987, 384-4 and 450-47.
6. Install all valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this Section.

### **3.02 WELDED PIPE JOINTS**

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

### **3.03 THREADED PIPE JOINTS**

- A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

### **3.04 NATURAL GAS**

- A. Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main. Teflon tape is acceptable for use on natural gas lines.
- B. Do not install gas pipe in a ventilation air plenum.

- C. If an above ground vent terminates in an area subject to snow accumulation, terminate the line at least five feet above grade.
- D. Install a shut off valve at each appliance. Provide a valved connection at the main for equipment and appliances furnished by others.
- E. Piping through a roof shall be run through an approved roof penetration with flashing and counter flashing.
- F. Each gas pressure reducing valve vent and relief valve vent shall be run separately to a point outside of the building, terminated with a screened vent cap, and located according to gas utility regulations.
- G. Clean all welded piping before all regulators and control valves. Test by placing target cloth over piping and blow with compressed air. Clean piping until target cloth is clean and free of debris.

### **3.05 VENTS AND RELIEF VALVES**

- A. Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

### **3.06 UNIONS AND FLANGES**

- A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

### **3.07 PIPING SYSTEM LEAK TESTS**

- A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
- B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.
- C. Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Division's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

- D. Do not insulate pipe until it has been successfully tested.
- E. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- F. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.
- G. Measure natural gas system test pressure with a water manometer or an equivalent device calibrated in increments not greater than 0.1 inch water column. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.
- H. Conduct fuel oil system test so as not to impose a pressure of more than 10 psig on the tank. Instead of a pressure test, suction lines may be tested under a vacuum of not less than 20 inches of mercury maintained for at least one hour.

I.

System	Pressure	Medium	Duration
Natural Gas	100 psig	Air	24 hr

- J. All pressure tests are to be documented on an approved form.
- K. On piping that can not be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

**END OF SECTION**

# Piping System Test Report

State of Utah Department of Administration Division of Facilities Development	Date Submitted: _____
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Project Name:	_____
---------------	-------

Location:	_____
-----------	-------

DFD Project No:	_____
-----------------	-------

Contractor:	_____
-------------	-------

Test Medium:	<input type="checkbox"/> HVAC	<input type="checkbox"/> Refrigeration	<input type="checkbox"/> Controls
	<input type="checkbox"/> Power Plant	<input type="checkbox"/> Plumbing	<input type="checkbox"/> Fire Sprinkler
	<input type="checkbox"/> Air	<input type="checkbox"/> Water	<input type="checkbox"/> Other:

Test performed per Specification Section No: \_\_\_\_\_

Specified Test Duration: _____ Hours	Specified Test Pressure: _____ PSIG
--------------------------------------	-------------------------------------

System Identification: \_\_\_\_\_

Describe Location: \_\_\_\_\_

Test Date: _____	
Start Test Time: _____	Initial Pressure: _____ PSIG
Stop Test Time: _____	Final Pressure: _____ PSIG

Tested By:	Witnessed By:
Title:	Title:
Signed	Signed:
Date:	Date:

Comments:

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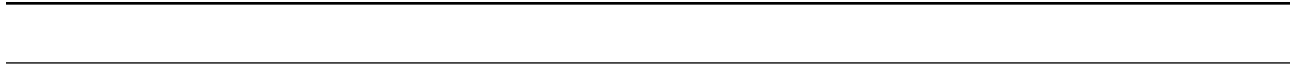
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**SECTION 22 11 13**  
**FACILITY WATER DISTRIBUTION PIPING**

**PART 1 – GENERAL****1.01 DESCRIPTION**

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this Section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 00 – Common Results for Plumbing.

**1.02 RELATED WORK**

- A. Section 00 72 00 – General Conditions
- B. Section 01 33 00 – Submittal Procedures
- C. Section 01 75 00 – Checkout and Startup Procedures
- D. Section 07 90 00 – Joint Fillers, Sealants and Caulking
- E. Section 09 90 00 – Painting
- F. Section 01 73 23 – Seismic Anchorage and Bracing
- G. Section 22 05 00 – Common Results for Plumbing
- H. Section 22 07 19 – Plumbing Piping Insulation

**1.03 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - 1. A13.1-2007 (R2013) – Scheme for Identification of Piping Systems
  - 2. B16.3-2011 – Malleable Iron Threaded Fittings: Classes 150 and 300
  - 3. B16.9-2012 – Factory-Made Wrought Buttwelding Fittings
  - 4. B16.11-2011 – Forged Fittings, Socket-Welding and Threaded

5. B16.12-2009 (R2014) – Cast Iron Threaded Drainage Fittings
  6. B16.15-2013 – Cast Copper Alloy Threaded Fittings: Classes 125 and 250
  7. B16.18-2012 – Cast Copper Alloy Solder Joint Pressure Fittings
  8. B16.22-2013 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  9. B16.24-2011 – Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
  10. B16.51-2013 – Copper and Copper Alloy Press-Connect Fittings
  11. ASME Boiler and Pressure Vessel Code
  12. BPVC Section IX-2015 Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
1. 1010-2004 – Performance Requirements for Water Hammer Arresters
- D. American Society for Testing and Materials (ASTM):
1. A47/A47M-1999 (R2014) – Standard Specification for Ferritic Malleable Iron Castings
  2. A53/A53M-2012 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  3. A183-2014 – Standard Specification for Carbon Steel Track Bolts and Nuts
  4. A269/A269M-2014e1 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  5. A312/A312M-2015 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
  6. A403/A403M-2014 – Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
  7. A536-1984 (R2014) – Standard Specification for Ductile Iron Castings
  8. A733-2013 – Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
  9. B32-2008 (R204) – 1Standard Specification for Solder Metal
  10. B43-2014 – Standard Specification for Seamless Red Brass Pipe, Standard Sizes

11. B61-2008 (R2013) – Standard Specification for Steam or Valve Bronze Castings
12. B62-2009 – Standard Specification for Composition Bronze or Ounce Metal Castings
13. B75/B75M-2011 – Standard Specification for Seamless Copper Tube
14. B88-2014 – Standard Specification for Seamless Copper Water Tube
15. B584-2014 – Standard Specification for Copper Alloy Sand Castings for General Applications
16. B687-1999 (R2011) – Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
17. C919-2012 – Standard Practice for Use of Sealants in Acoustical Applications
18. D1785-2012 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
19. D2000-2012 – Standard Classification System for Rubber Products in Automotive Applications
20. D2564-2012 – Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
21. D2657-2007 – Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
22. ASTM D 2765 – Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
23. ASTM D 6394 – Specification for Sulfone Plastics (SP).
24. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
25. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
26. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
27. ASTM F 876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
28. ASTM F 877 – Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.

29. ASTM F 1960 – Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubin
  30. D2855-1996 (R2010) – Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
  31. D4101-2014 – Standard Specification for Polypropylene Injection and Extrusion Materials
  32. E1120-2008 – Standard Specification for Liquid Chlorine
  33. E1229-2008 – Standard Specification for Calcium Hypochlorite
  34. F2389-2010 – Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
  35. F2620-2013 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
  36. F2769-2014 – Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
- E. American Welding Society (AWS):
1. A5.8M/A5.8-2011-AMD1 – Specification for Filler Metals for Brazing and Braze Welding
- F. International Code Council (ICC):
1. IPC-2021 – International Plumbing Code
- G. Manufacturers Specification Society (MSS):
1. SP-58-2009 – Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
  2. SP-72-2010a – Ball Valves with Flanged or Butt-Welding Ends for General Service
  3. SP-110-2010 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- H. NSF International (NSF):
1. 14-2015 – Plastics Piping System Components and Related Materials
  2. 61-2014a – Drinking Water System Components – Health Effects
  3. 372-2011 – Drinking Water System Components – Lead Content

- I. Plumbing and Drainage Institute (PDI):
  - 1. PDI-WH 201-2010 – Water Hammer Arrestors

#### **1.04 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.
- B. Information and material submitted under this Section shall be marked “SUBMITTED UNDER SECTION 22 11 13 – FACILITY WATER DISTRIBUTION PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. All items listed in Part 2 - Products.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

#### **1.05 QUALITY ASSURANCE**

- A. A certificate shall be submitted prior to welding of steel piping showing the Welder's certification. The certificate shall be current and no more than one year old. Welder's qualifications shall be in accordance with ASME BPVC Section IX.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- C. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.

#### **1.06 SPARE PARTS**

- A. For mechanical press-connect fittings, provide tools required for each pipe size used at the facility.

## 1.07 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to Owner's Representative 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

## PART 2 – PRODUCTS

### 2.01 MATERIALS

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

## 2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, drawn temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
  2. Copper, Pressure-Seal Fittings:
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Viega; Plumbing & Heating Systems.
      - 2) Nibco
      - 3) Mueller
    - c. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    - d. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- C. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

## 2.03 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
  2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

- C. A. CPVC Schedule 80 Pipe: ASTM F441/F 441M.
  - 1. CPVC Schedule 40 Fittings: ASTM F438, socket type.
  - 2. CPVC Schedule 80 Fittings: ASTM F439, socket, ASTM F437, threaded, ASTM F439, socket type or ASTM F437, threaded type.

## **2.04 PEX PIPE AND FITTINGS**

- A. PEX-a (Engel-method crosslinked polyethylene) piping: ASTM F 876 and F877 (CAN/CSA-B137.5) by Uponor.
- B. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
  - 1. UNS No. C69300 lead-free (LF) brass.
  - 2. UNS No. C27453 lead-free (LF) brass.
  - 3. 20% Glass-filled Polysulfone as specified in ASTM D 6394.
  - 4. Unreinforced Polysulfone (Group 01, Class 1, Grade 2) as specified in ASTM D 6394.
  - 5. Polyphenylsulfone (Group 03, Class 1, Grade 2) as specified in ASTM D 6394.
  - 6. Blend of polyphenylsulfone (55-80%) and unreinforced Polysulfone (REM.) as specified in ASTM D 6394.
  - 7. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".
- C. Pre-sleeved piping (1/2 inch (16mm) through 3/4 inch (20mm) nominal pipe size): PEX-a piping, with a high-density polyethylene (HDPE) corrugated sleeve.
- D. Pre-insulated piping (1/2 inch (16mm) through 2 inch (50mm) nominal pipe size): PEX-a piping, with a closed-cell polyethylene foam insulation.
- E. Multi-port tees: multiple-outlet fitting complying with ASTM F 877 (CAN/CSA B137.5); with ASTM F 1960 inlets and outlets.
  - 1. Engineered polymer branch multi-port tee.
  - 2. Engineered polymer flow-through multi-port tee.
  - 3. Engineered polymer commercial branch multi-port tee.



4. Engineered polymer commercial branch multi-port elbow.
  5. Engineered polymer commercial flow-through multi-port tee.
- F. Manifolds: multiple-outlet assembly complying with ASTM F 877 (CAN/CSA B137.5); with ASTM F 1960 outlets.
1. Engineered polymer valved manifold.
  2. Engineered polymer valveless manifold.
  3. Lead - free copper branch manifold.
  4. Lead-free copper valved manifold.

## **2.05 TRAP PRIMER WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ASME B16.18 Solder joints.
- C. Solder: ASTM B32 alloy type Sb5. Provide non-corrosive flux.

## **2.06 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Less than 3 inches, brass or bronze; 3 inches and greater, cast iron or semi-steel.

## **2.07 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between pipe of dissimilar metals.

## **2.08 STERILIZATION CHEMICALS**

- A. Hypochlorite: ASTM E1120.
- B. Liquid Chlorine: ASTM E1229.

## **2.09 WATER HAMMER ARRESTER**

- A. Closed copper tube chamber with permanently sealed 60 psig air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated

with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:

1. All solenoid valves.
2. All groups of two or more flush valves.
3. All quick opening or closing valves.
4. All medical washing equipment.

## **2.10 TRANSITION FITTINGS**

### **A. PEX-to-Metal Transition Fittings:**

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. PEX-a to Threaded Brass Transition: One-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. PEX-a to Brass Sweat Transition: One-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
4. PEX-a to Flange Transition: Two-piece fitting with one steel flange conforming to ASME B 16.5 and one lead free (LF) brass adapter conforming to ASTM F 1960.
5. PEX-a to Groove Transition: One-piece lead free (LF) brass fitting with one CSA B242-05 groove end in either iron pipe size (IPS) or copper tube size (CTS) and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
6. PEX-a to Water Meter Transition: Two-piece fitting with one NPSM union thread and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
7. PEX-a to Copper Press Transition: One-piece lead free (LF) brass fitting with one ASME B16.51 copper press end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

### **B. PEX-to-Thermoplastic Transition Fittings:**

1. PEX-a to CPVC Transition: Thermoplastic fitting with one spigot or socket end and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. General: Comply with the International Plumbing Code and the following:
1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Owner or specified in other sections.
  2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
  3. All pipe runs shall be laid out to avoid interference with other work/trades.
  4. Install union and shut-off valve on pressure piping at connections to equipment.
  5. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  6. Penetrations:
    - a. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 90 00 – Joint Fillers, Sealants and Caulking. Bio-based materials shall be utilized when possible.
    - b. Acoustical sealant: Where pipes pass through sound rated walls, seal around the pipe penetration with an acoustical sealant that is compliant with ASTM C919.
  7. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.
- B. Domestic Water piping shall conform to the following:

1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

### **3.02 PIPING SCHEDULE**

- A. Aboveground Water-Service Piping NPS 3/4 to NPS 3 shall be any of the following:
  1. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed or copper, pressure-seal fittings; and pressure-sealed joints.
  2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
  3. CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
  4. NPS 1 to NPS 2 PEX with cold expansion joints.

### **3.03 TESTS**

- A. General: Test system either in its entirety or in sections. Submit testing plan to Owner's Representative 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 150 psig gauge for two hours. No decrease in pressure is allowed. Provide a pressure gauge with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
- D. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

**END OF SECTION**

**SECTION 22 11 19**  
**DOMESTIC WATER PIPING SPECIALTIES**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. This Section includes the following domestic water piping specialties:
  - 1. Vacuum breakers
  - 2. Backflow preventers
  - 3. Balancing valves
  - 4. Strainers
  - 5. Outlet boxes
  - 6. Hose bibbs
  - 7. Wall hydrants
  - 8. Drain valves
  - 9. Water hammer arresters
  - 10. Air vents
  - 11. Trap-seal primer valves
  
- B. Related Sections include the following:
  - 1. Section 22 05 19 – Meters and Gauges for Plumbing Piping for thermometers, pressure gauges, and flow meters in domestic water piping.

**1.02 PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

**1.03 SUBMITTALS**

- A. Product Data: For each type of product indicated.
  
- B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include operation, and maintenance manuals.

#### **1.04 QUALITY ASSURANCE**

- A. 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 for intended use.
- B. NSF Compliance:
  - 1. Comply with NSF 14, Plastics Piping Components and Related Materials, for plastic domestic water piping components.
  - 2. Comply with NSF 61, Drinking Water System Components – Health Effects; Sections 1 through 9.

### **PART 2 – PRODUCTS**

#### **2.01 VACUUM BREAKERS**

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. FEBCO; SPX Valves & Controls.
    - c. Watts Industries, Inc.; Water Products Div.
    - d. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1001.
  - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 4. Body: Bronze.
  - 5. Inlet and Outlet Connections: Threaded.
  - 6. Finish: Chrome plated.
- B. Hose-Connection Vacuum Breakers:

1. Manufacturers:
  - a. Conbraco Industries, Inc.
  - b. MIFAB, Inc.
  - c. Watts Industries, Inc.; Water Products Div.
  - d. Woodford Manufacturing Company.
  - e. Zurn Plumbing Products Group.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or Rough bronze.

C. Pressure Vacuum Breakers:

1. Manufacturers:
  - a. Conbraco Industries, Inc.
  - b. FEBCO; SPX Valves & Controls.
  - c. Watts Industries, Inc.; Water Products Div.
  - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:
  - a. Valves: Ball type, on inlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers:
  - a. Conbraco Industries, Inc.

- b. Watts Industries, Inc.; Water Products Div.
  - c. Woodford Manufacturing Company.
  - d. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1035.
  - 3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
  - 4. Body: Bronze.
  - 5. End Connections: Threaded.
  - 6. Finish: Chrome plated.
- E. Spill-Resistant Vacuum Breakers:
- 1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. Watts Industries, Inc.; Water Products Div.
  - 2. Standard: ASSE 1056.
  - 3. Operation: Continuous-pressure applications.
  - 4. Accessories:
    - a. Valves: Ball type, on inlet.

## **2.02 BACKFLOW PREVENTERS**

- A. Reduced-Pressure-Principle Backflow Preventers:
- 1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. FEBCO; SPX Valves & Controls.
    - c. Watts Industries, Inc.; Water Products Div.
    - d. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1013.



3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
  - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
  - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

### **2.03 STRAINERS FOR DOMESTIC WATER PIPING**

#### **A. Y-Pattern Strainers:**

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2) and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.020 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
  - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

### **2.04 HOSE BIBBS**

#### **A. Hose Bibbs:**

1. Standard: ASME A112.18.1 for faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Refer to Plumbing Fixture Schedule on drawings for finishes.

## **2.05 DRAIN VALVES**

### **A. Ball-Valve-Type, Hose-End Drain Valves:**

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Body: Copper alloy.
4. Ball: Chrome-plated brass.
5. Seats and Seals: Replaceable.
6. Handle: Vinyl-covered steel.
7. Inlet: Threaded or solder joint.
8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## **2.06 WATER HAMMER ARRESTERS**

### **A. Water Hammer Arresters:**

1. Manufacturers:
  - a. Josam Company.
  - b. MIFAB, Inc.

- c. PPP Inc.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Tyler Pipe; Wade Div.
  - f. Watts Drainage Products Inc.
  - g. Zurn Plumbing Products Group.
2. Standard: ASSE 1010 or PDI-WH 201.
  3. Type: Copper tube with piston.
  4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## **2.07 AIR VENTS**

### **A. Bolted-Construction Automatic Air Vents:**

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

### **B. Welded-Construction Automatic Air Vents:**

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Refer to Section 22 05 00 – Common Results for Plumbing for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
  - 2. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- E. Install water hammer arresters in water piping according to PDI-WH 201 and drawings.
- F. Install air vents at high points of water piping. Install drain piping and discharge to floor drain.
- G. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

### **3.02 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- C. Connect wiring according to Section 26 05 19 – Low-Voltage Conductors and Cables.

### **3.03 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
  2. Intermediate atmospheric-vent backflow preventers.
  3. Reduced-pressure-principle backflow preventers.
  4. Double-check backflow-prevention assemblies.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 – Identification for Plumbing Piping and Equipment.

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and prepare test reports:
1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and vacuum breaker assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

### **3.05 ADJUSTING**

- A. Confirm flow rate and direction of flow for automatic balancing valves.

**END OF SECTION**

**SECTION 23 00 00**  
**BASIC HVAC REQUIREMENTS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning, piping, etc. as indicated on the drawings and specified herein.
- B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

**1.02 SUBMITTALS**

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01 33 00 – Submittal Procedures.
- B. Data to be submitted shall include but not be limited to:
  - 1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
  - 2. Complete assembly, and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
  - 3. Weight of all component parts and assembled weight.
  - 4. Electrical characteristics, wiring, diagrams, etc.
  - 5. Sample data sheet of equipment nameplate(s) including information contained thereon.
  - 6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.
  8. Type of adhesives, binders, joint cement, mastics.
  9. Proposed insulation procedures and installation methods.
  10. Spare parts list
  11. Special tools list
- C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.
- D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.

### **1.03 RELATED WORK**

- A. Division 01 – General Requirements
- B. Section 01 33 00 – Submittal Procedures
- C. Section 01 74 00 – Cleaning and Waste Management
- D. Section 01 75 00 – Checkout and Startup Procedures
- E. Section 03 30 00 – Cast-In-Place Concrete
- F. Section 05 31 00 – Metal Decking
- G. Section 05 50 00 – Metal Fabrications
- H. Section 07 90 00 – Joint Fillers, Sealants, and Caulking
- I. Section 09 90 00 – Painting
- J. Section 01 73 23 – Seismic Anchorage and Bracing
- K. Section 26 05 00 – Basic Electrical Requirements
- L. Section 26 05 19 – Low-Voltage Conductors and Cables
- M. Section 26 29 13.13 – Low-Voltage Enclosed Motor Controllers-Full Voltage
- N. Section 26 29 26 – Low Voltage Variable Frequency Motor Controllers

**1.04 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 01.
- B. Operation and Maintenance Manuals shall be submitted for all equipment.

**1.05 MANUFACTURER'S INSTRUCTIONS**

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Furnish Owner, indexed and bound in loose leaf binders, three (3) complete sets of Operating and Maintenance Instructions and pertinent manufacturers' literature and information on all of the apparatus and equipment under this Division of the Specifications.
- G. Submit all instruction books and manuals in accordance with Division 01.

**1.06 CODES, PERMITS AND STANDARDS**

- A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.



D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Diffusion Council (ADC)
3. Air Moving and Conditioning Association (AMCA)
4. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
5. American National Standards Institute (ANSI)
6. American Society for Testing and Materials (ASTM)
7. American Society of Mechanical Engineers (ASME)
8. Factory Mutual (FM)
9. National Electric Code (NEC)
10. NFPA 90A - Air Conditioning and Ventilation Systems
11. Occupational Safety and Health Standards (OSHA)
12. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
13. International Building Code - 2021 edition
14. International Mechanical Code - 2021 edition
15. International Plumbing Code - 2021 edition
16. State and local codes, ordinances and statutes
17. Underwriters Laboratories (UL)
18. Others as designated in the specifications.

#### **1.07 QUALITY ASSURANCE**

A. All material and equipment shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

- B. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- D. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.
- E. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other Specification Sections for any exceptions and/or additional requirements.
  - 2. Refer to all other Sections for quality assurance requirements for systems and equipment specified therein.
  - 3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
  - 4. The products and execution of work specified in Division 23 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the Owner's representative.
  - 5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
  - 6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.

7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  8. Use of asbestos products or equipment or materials containing asbestos is prohibited.
- F. HVAC Mechanical Systems Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVC Section IX. Provide proof of current certification.
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the associated code.
- G. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Owner's representative with submittals. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material and removal by the Contractor and no additional cost or time to the Owner.
- H. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract documents to the Owner's representative for resolution. Provide written hard copies and computer files on CD or DVD of manufacturer's installation instructions to the Owner's representative with submittals prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received and approved by the Owner's representative. Failure to furnish these recommendations is a cause for rejection of the material.
  2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons

standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to, all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to the Owner's representative for resolution. Failure of the Contractor to resolve, or point out any issues will result in the Contractor correcting at no additional cost or time to the Owner.

3. Complete coordination/shop drawings shall be required in accordance with Paragraph, SUBMITTALS. Construction work shall not start on any system until the coordination/shop drawings have been approved by the Owner's representative.
  4. Workmanship/craftsmanship will be of the highest quality and standards. The Owner reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Owner.
- I. Upon request by the Owner's representative, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.

#### **1.08 DELIVERY, STORAGE AND HANDLING**

##### **A. Protection of Equipment:**

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage or theft.
2. Large equipment such as boilers, chillers, cooling towers, fans, and air handling units if shipped on open trailer trucks shall be covered with shrink on plastics or water proof tarpaulins that provide protection from exposure to rain, road salts and other transit hazards. Protection shall be kept in place until equipment is moved into a building or installed as designed.
3. Repair damaged equipment in first class, new operating condition and appearance; or, replace same as determined and directed by the Owner's representative. Such repair or replacement shall be at no additional cost or time to the Owner.

4. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
5. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
6. Protect plastic piping and tanks from ultraviolet light (sunlight).

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Owner.
4. Boilers shall be left clean following final internal inspection by Owner's insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

**1.09 JOB CONDITIONS – WORK IN EXISTING BUILDING**

- A. Building Operation: Owner's employees will be continuously operating and managing all facilities, including temporary facilities that serve the project.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the Owner.
- C. Phasing of Work: Comply with all requirements shown on contract documents. Contractor shall submit a complete detailed phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.
- D. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. Storm water or ground water leakage is prohibited. Provide daily clean-up of construction and demolition

debris on all floor surfaces and on all equipment being operated by the Owner. Maintain all egress routes and safety systems/devices.

- E. Acceptance of Work for Owner’s Operation: As new equipment, systems and facilities are made available for operation and these items are deemed of beneficial use to the Owner, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Owner’s personnel.

**1.10 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the contract documents and shown in the maintenance manuals. Identification for piping is specified in Section 09 90 00 – Painting.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 5 mm (3/16 inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 90 00 – Painting permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 5 mm (3/16 inch) high riveted or bolted to the equipment.
- D. Control Items: Label all instrumentation, temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:

<b>Yellow / Green</b>	Supply air
<b>Blue</b>	Exhaust, outside, return and mixed air
<b>Nomenclature</b>	Include the following: Direction of air flow. Duct service (supply, return, exhaust, etc.)

**1.11 GASKETS AND CONNECTORS**

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.
- C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial/commercial grade.
- D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.
- E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring-type vibration isolators.

## 2.02 PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations through beams or ribs are prohibited but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Owner's representative.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.



- J. Sealant and Adhesives: Shall be as specified in Section 07 90 00 – Joint Fillers, Sealants, and Caulking.

### **2.03 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 450 mm (18 inches) high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

### **2.04 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Owner's representative, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Owner's representative.
- E. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

### **2.05 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035 inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.06 ASBESTOS**

- A. Materials containing asbestos are prohibited.

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

- A. If an installation is unsatisfactory to the Owner's representative, the Contractor shall correct the installation at no additional cost or time to the Owner.

### **3.02 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. The coordination/shop drawings shall be submitted for review. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Equipment coordination/shop drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gauges and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the contract documents.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill is prohibited, except as permitted by Owner's representative where working area space is limited.
  - 2. Locate holes to avoid interference with structural members such as slabs, columns, ribs, beams or reinforcing. Holes shall be laid out in advance and drilling

done only after approval by Owner's representative. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Owner's representative for approval.

3. Do not penetrate membrane waterproofing.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- G. Electrical Interconnection of Instrumentation or Controls: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Devices shall be located so they are easily accessible for testing, maintenance, calibration, etc. The Owner's representative has the final determination on what is accessible and what is not. Comply with NFPA 70.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Owner's representative. Damaged or defective items in the opinion of the Owner's representative, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Concrete and Grout: Use concrete and non-shrink grout 20 MPa (3000 psig) minimum, specified in Section 03 30 00 – Cast-In-Place Concrete.
- J. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Install steam piping expansion joints as per manufacturer's recommendations.
- L. Work in Existing Building:
1. Perform as specified in Division 01 for relocation of existing equipment, alterations and restoration of existing building(s).

2. As specified in Division 01, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
- M. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and data/telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall not be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 feet) above the equipment or to ceiling structure, whichever is lower (NFPA 70).
- N. Inaccessible Equipment:
1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance or inspections, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost or time to the Owner.
  2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to motors, fans, pumps, belt guards, transformers, high voltage lines, conduit and raceways, piping, hot surfaces, and ductwork. The Owner's representative has final determination on whether an installation meets this requirement or not.

### **3.03 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Paragraph, Arrangement and Installation of Equipment and Piping apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

**3.04 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Owner under specified restrictions of phasing and maintenance of service requirements as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Owner's operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Owner's representative will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Professional Engineer registered in the State or Commonwealth in which the project is located.
- F. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- G. Follow approved rigging plan.

Restore building to original condition upon completion of rigging work.

**3.05 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels designed by a structural engineer, secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Owner's representative.
- B. Use of chain pipe supports; wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above are prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.

D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-58. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.

E. HVAC Vertical Pipe Supports:

1. Up to 6-inch pipe, 30 feet long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.

F. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.

2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.

3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.

2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Chiller foundations shall have horizontal dimensions that exceed chiller base frame dimensions by at least 150 mm (6 inches) on all sides. Structural contract documents shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.

3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

For seismic anchoring, refer to Section 01 73 23 – Seismic Anchorage and Bracing.

### **3.06 MECHANICAL DEMOLITION**

- A. Rigging access, other than indicated on the contract documents, shall be provided by the Contractor after approval for structural integrity by the Owner's representative. Such access shall be provided without additional cost or time to the Owner. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Owner's personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Debris accumulated in the area to the detriment of plant operation is prohibited. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the Owner, and Contractor shall follow all directives of the Owner's representative with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from property per Section 01 74 00 – Cleaning and Waste Management. This includes all concrete pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with contract documents where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the contract documents of the other disciplines in the project for additional facilities to be demolished or handled.

### **3.07 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Owner, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 90 00 – Painting.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.

2. The following material and equipment shall not be painted:
  - a. Motors, controllers, control switches, and safety switches.
  - b. Control and interlock devices.
  - c. Regulators
  - d. Pressure reducing valves.
  - e. Control valves and thermostatic elements.
  - f. Lubrication devices and grease fittings.
  - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
  - h. Valve stems and rotating shafts.
  - i. Pressure gauges and thermometers.
  - j. Glass.
  - k. Nameplates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats. This may include painting exposed metals where hangers were removed or where equipment was moved or removed.
6. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.
7. Lead based paints are prohibited.

### **3.08 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and



identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 90 00 – Painting.
- D. Attach ceiling grid label on ceiling grid location directly underneath above-ceiling air terminal, control system component, valve, filter unit, fan etc.

### **3.09 MOTOR AND DRIVES**

- A. Use synchronous belt drives only on equipment controlled by soft starters or variable frequency drive motor controllers without a bypass contactor. Use V-belt drives on all other applications.
- B. Alignment of V-Belt Drives: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- C. Alignment of Synchronous Belt Drives: Set driving and driven shafts parallel and align so that the corresponding pulley flanges are in the same plane.
- D. Alignment of Direct-Connect Drives: Securely mount motor in accurate alignment so that shafts are per coupling manufacturer's tolerances when both motor and driven machine are operating at normal temperatures.

### **3.10 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. Field-check all devices for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings or devices. A minimum of 1 quart of oil and 1 pound of grease of manufacturer's recommended grade and type for each different application shall be provided; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Owner's representative in unopened containers that are properly identified as to application.
- C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- D. All lubrication points shall be extended to one side of the equipment.

### **3.11 STARTUP, TEMPORARY OPERATION AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.
- C. Startup of equipment shall be performed as described in equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Division 01.

### **3.12 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Division 01, and in individual Division 23 Specification Sections and submit the test reports and records to the Owner's representative.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost or time to the Owner.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work. Rescheduling of these tests shall be requested in writing to Owner's representative for approval.
- D. No adjustments may be made during the acceptance inspection. All adjustments shall have been made by this point.

### **3.13 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct the personnel responsible in operation and maintenance of the system.

**END OF SECTION**

**SECTION 23 05 13**

**GENERAL MOTOR REQUIREMENTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of motors for HVAC equipment.
- B. A complete listing of common acronyms and abbreviations are included in //Section 23 05 00, BASIC HVAC REQUIREMENTS.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 00, SUBMITTAL PROCEDURES.
- C. Section 23 05 00, BASIC HVAC REQUIREMENTS.
- D. Section 23 08 00, Commissioning of HVAC Systems
- E. Section 26 05 00, BASIC ELECTRICAL REQUIREMENTS.
- F. Section 26 24 19, MOTOR CONTROL CENTERS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Bearing Manufacturers Association (ABMA):
  - 9-2015.....Load Ratings and Fatigue Life for Ball Bearings
  - 11-2020.....Load Ratings and Fatigue Life for Roller Bearings
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - 90.1-2022.....Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - 112-2017.....Standard Test Procedure for Polyphase Induction Motors and Generators

841-2021.....IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors--Up to and Including 370 kW (500 hp)

E. National Electrical Manufacturers Association (NEMA):

MG 1-2021.....Motors and Generators

MG 2-2023.....Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

250-2021.....Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-2023.....National Electrical Code (NEC)

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC", with applicable paragraph identification.

C. Submit motor submittals with driven equipment.

D. Shop Drawings:

1. Provide documentation to demonstrate compliance with contract documents.

2. Motor nameplate information shall be submitted including electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.

E. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.

2. Include complete diagrams of the internal wiring for each item of equipment.

3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Certification: Two weeks prior to final inspection, unless otherwise noted, certification shall be submitted to the Owner' stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.
- H. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

#### 1.5 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with Owner's requirements.
- E. Certification documentation shall be provided to Owner's representative 21 working days prior to submitting the request for final inspection. The documentation shall include all

test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## PART 2 - PRODUCTS

### 2.1 MOTORS

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- B. For severe duty TEFC motors, IEEE 841 shall apply.
- C. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- D. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
  - 1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- F. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.

2. Three phase:
  - a. Motors connected to 208-volt systems: 200 volts.
  - b. Motors, less than 74.6 kW (100 hp), connected to 240-volt or 480-volt systems: 208-230/460 volts, dual connection.
  - c. Motors, 74.6 kW (100 hp) or larger, connected to 240-volt systems: 230 volts.
  - d. Motors, 74.6 kW (100 hp) or larger, connected to 480-volt systems: 460 volts.
  - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA MG 1 for connection to the nominal system voltage shown on the drawings.
- G. Number of phases shall be as follows:
  1. Motors, less than 373 W (1/2 hp): Single phase.
  2. Motors, 373 W (1/2 hp) and larger: 3 phase.
  3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (1 hp), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration, and running torque without exceeding nameplate ratings or considering service factor.
- J. Motor Enclosures:
  1. Shall be the NEMA types as specified and/or shown in the Contract Documents.
  2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
    - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.

- b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
  - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

K. Electrical Design Requirements:

1. Motors shall be continuous duty.
2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (176 degrees F).
4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General-Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both, or NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors.

L. Mechanical Design Requirements:

1. Bearings shall be rated in accordance with ABMA 9 or ABMA 11 for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hours rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.



5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

M. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional cost or time to the Owner.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
  - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

- N. Additional requirements for specific motors, as indicated in the other sections listed in paragraph, RELATED SECTIONS shall also apply.
- O. NEMA Premium Efficiency Electric Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 W (1 hp) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 W (1 hp) or more with open, drip-proof, or TEFC enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled (TEFC)			
Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM	Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- P. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM, and 3600 RPM. Power factor correction capacitors shall be provided unless the motor meets the 0.90 requirement without it or if the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.
- Q. Energy Efficiency of Small Motors (Motor Efficiencies): All motors under 746 W (1 hp) shall meet the requirements of the DOE Small Motor Regulation.

Polyphase Open Motors Average full load efficiency				Capacitor-start capacitor-run and capacitor-start induction run open motors Average full load efficiency			
Rating kW (hp)	6 poles	4 poles	2 poles	Rating kW (hp)	6 poles	4 poles	2 poles
0.18 (0.25)	67.5	69.5	65.6	0.18 (0.25)	62.2	68.5	66.6
0.25 (0.33)	71.4	73.4	69.5	0.25 (0.33)	66.6	72.4	70.5
0.37 (0.5)	75.3	78.2	73.4	0.37 (0.5)	76.2	76.2	72.4
0.55 (0.75)	81.7	81.1	76.8	0.55 (0.75)	80.2	81.8	76.2

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with manufacturer’s recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.
- B. If an installation is unsatisfactory to the Owner’s Representative, the Contractor shall correct the installation at no additional cost or time to the Owner.

3.2 FIELD TESTS

- A. All tests shall be witnessed by the Commissioning Agent or by the Owner’s Representative.
- B. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.
- C. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- D. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

- E. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

### 3.3 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Owner's Representative and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

### 3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### 3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for one hour to instruct Owner's personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

**END OF SECTION**

**SECTION 23 05 23  
GENERAL-DUTY VALVES FOR HVAC PIPING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Conditions and Specification Book Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes Valves and Valve Accessories for Hydronic Systems, Not Steam Systems:
  - 1. Bronze ball valves.
  - 2. Bronze lift check valves.
  - 3. Bronze swing check valves.
  - 4. Iron swing check valves.
  - 5. Chainwheels.
- B. Related Sections:
  - 1. Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

**1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of valve indicated.

**1.5 QUALITY ASSURANCE**

- A. Source Limitations for Valves: Obtain each type of valve from single source from

single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.

## D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

## E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

## F. Valve-End Connections:

1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

## G. Valve Bypass and Drain Connections: MSS SP-45.

**2.2 BRONZE BALL VALVES**

## A. Bronze Ball Valves, Three-Piece with Full Port Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.; Apollo Valves.
  - b. Neles-Jamesbury, Inc.
  - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.

- d. Body Design: Three piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE.
- h. Stem: 316L Stainless steel.
- i. Ball: 316L Stainless steel, vented.
- j. Port: Full.

## 2.3 BRONZE LIFT CHECK VALVES

### A. Class 150, Lift Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nibco
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Mueller.
- 2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 250 psig wog.
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B 61 or ASTM B 584, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

## 2.4 BRONZE SWING CHECK VALVES

### A. Class 125, Bronze Horizontal Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by



one of the following:

- a. Nibco
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Mueller.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Nibco
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Mueller

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 300 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

## 2.5 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Babbitt Steam Specialty Co.
  2. Roto Hammer Industries.
  3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  2. Attachment: For connection to valve stems.
  3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
  4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Lift Check Valves: With stem upright and plumb.

### **3.3 ADJUSTING**

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### **3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service:
    - a. NPS 2 and Smaller: Ball
  - 2. Dead-End Service: Single-flange (lug) type butterfly valves.
  - 3. Throttling Service except Steam: Ball whenever allowable by size, and butterfly if larger required.
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

### **3.5 HEATING-WATER VALVE SCHEDULE**

#### **A. Pipe NPS 2 and Smaller:**

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.

**END OF SECTION**

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**SECTION 23 05 29**  
**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Pipe, duct, and equipment hangers and supports.
2. Anchors, equipment bases and supports.
3. Sleeves and seals.
4. Flashing, counter flashing and pipe stacks.
5. Firestopping.

C. Related Sections:

1. Section 00 72 00 – General Conditions.
2. Section 00 73 00 – Supplementary Conditions.
3. Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.
4. Division 03 Section – Concrete.
5. Section 07 90 00 – Joint Fillers, Sealants and Caulking.
6. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
7. Section 23 07 00 – HVAC Insulation.

## 1.02 REFERENCES

### A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Section 00 72 00 – General Conditions for the list of applicable regulatory requirements.
4. Refer to Section 23 05 00 – Basic HVAC Requirements for codes and standards and other general requirements.

### B. Code of Federal Regulations 29 CFR 1910.7:

1. Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

### C. National Fire Protection Association (NFPA)

1. NFPA-13 Installation of Sprinkler Systems
2. NFPA-14 Installation of Standpipe and Hose Systems

### D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):

1. Seismic Restraint Manual: Guidelines for Mechanical Systems - latest edition for the support of ductwork.

### E. Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.

### F. UL Fire Resistance Directory, latest edition.

## 1.03 SUBMITTALS

- A. Submit under provisions of Section 23 05 00– Basic HVAC Requirements - Review of Materials and Section 00 72 00 – General Conditions.
- B. Submit calculations showing compliance with Section 01 73 23 – Seismic Anchorage and Bracing, for piece of equipment whether supported or braced from above or below.

- C. Submit calculations showing compliance with Section 01 73 23 – Seismic Anchorage and Bracing for seismic bracing of ductwork and piping.
- D. Submit shop drawing of hanger and support spacing, framing and attachment methods.

## **PART 2 – PRODUCTS**

### **2.01 PIPE HANGERS AND SUPPORTS**

- A. Hangers for Pipe Sizes ½ to 1-1/2 Inch : 316 Stainless steel, adjustable swivel ring, UL listed, Grinnell Fig. 69 or equal. Use plastic coated hangers at all uninsulated copper piping.
- B. Hangers for Pipe Sizes 2 Inches and Cold Pipe Sizes 6 Inches and Over: 316 Stainless steel, adjustable, clevis, UL listed, Grinnell Fig. 260 or equal.
- C. Trapeze Supports: 12 gauge stainless steel channel complete with nuts, pipe clamps, pipe straps, and drive-in end caps. Furnish cushion strip on all uninsulated copper piping.
- D. Pipe Supported Tight to Wall, Floor, or Ceiling: Superstrut A1200, Unistrut P1000, or equal, 12 gauge stainless channel complete with pipe clamps, nuts, bolts, and end caps. Furnish cushion strip on all uninsulated copper piping.
- E. Vertical Support: Stainless steel riser clamp, UL listed, Grinnell Fig. 261, Superstrut C720, or equal.
- F. Floor Support for Pipe Sizes to 4 Inches and Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- G. Shield for Insulated Piping 2 Inches and Smaller: 18-gauge Stainless steel shield over insulation in 180 degree segments, at least 12 inches long at pipe support.
- H. Concrete Anchors: In accordance with Section 03 15 00 – Concrete Accessories.

### **2.02 DUCT SUPPORTS**

- A. See Section 23 31 13 – Metal Ducts and Ducts Accessories or Section 23 31 16 – Nonmetal Ducts and Duct Accessories.

### **2.03 HANGER RODS**

- A. Stainless steel, threaded both ends, threaded one end, or continuously threaded.



## 2.04 ATTACHMENTS TO STRUCTURE

- A. Inserts for new formed concrete construction: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. For Suspension from New Formed Concrete Structure: Grinnell Figure 282, Superstrut 452, or equal, UL listed for the rod sizes, Grinnell, Fig. 282, Superstrut 452, or equal.
- B. Connection to Existing Concrete Structure: Hilti Kwik-Bolt, Phillips or equal, wedge type expansion anchors. Powder-driven fasteners may be used only for flexible duct, metal duct up to 16 inches round (or rectangular equivalent), and for air inlet and outlet wire seismic braces, and only within the parameters of the fastener's ICBO report. Provide current ICBO report. Do not use powder-driven fasteners for pipes or conduits.
- C. For Suspension from New Formed Concrete Structure: B-Line B3014, Grinnell Figure 282, Superstrut 452, or equal, adjustable concrete insert.
- D. For Support on New Concrete: Stainless steel headed bolts.
- E. Welded Connection to Steel Beams: B-Line B3083, Grinnell, Superstrut, or equal, steel welded beam attachment.
- F. Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

## 2.05 SUPPORTS, BRACING, AND ACCESSORIES

- A. Miscellaneous Steel: Stainless steel angles, channels, brackets, rods, clamps, etc., of new materials conforming to ASTM A36.
- B. Fasteners: Bolts and nuts, except as otherwise specified, shall conform to ASTM Standard Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. Bolts, washers, nuts, anchor bolts, screws and other hardware used outdoors or inside the penthouse shall be stainless steel, and stainless steel nuts shall have a free running fit. Provide bolts of ample size and strength for the purpose intended. Ferrous metal components below grade shall be stainless steel.
- C. Sheet Metal Screws: Plated, size 10 minimum.
- D. Pre-engineered duct and pipe bracing systems may be Mason Industries Seismic Sway Brace System or equal.

## 2.06 COUNTER FLASHING

- A. Metal Flashing: 26-gauge stainless steel.

- B. Flexible Flashing: 47-mil thick sheet butyl; compatible with roofing.
- C. Caps: Steel, 16 gauge.

## **2.07 EQUIPMENT CURBS**

- A. See Architectural and Structural Drawings for the design detail of the equipment curb.

## **2.08 SLEEVES**

- A. Adjust-To-Crete, AMI Products, or equal, 24 gauge, electro-galvanized adjustable sleeve, up to 6" diameter. For 8 inches and larger, provide galvanized standard weight steel pipe sleeves
- B. Sleeves for Round Ductwork: Form with stainless steel.
- C. Sleeves for Rectangular Ductwork: Form with stainless steel or wood.
- D. Caulk: Acrylic sealant of quality specified in Section 07 90 00 – Joint Fillers, Sealants and Caulking.

## **2.09 FABRICATION**

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers for installation without disengagement of supported pipe.

## **2.10 FINISH**

- A. Mill finish on exposed stainless steel hangers and supports.

## **PART 3 – EXECUTION**

### **3.01 ATTACHMENTS TO STRUCTURE**

- A. Concrete Structure: Locate anchors from Edge condition and at a spacing to obtain maximum working loads specified in the applicable ICC report.
  - 1. See structural drawings for additional restrictions for locating anchors.
- B. Steel Structure: Attach at beam axis. Avoid eccentric loads wherever possible.
- C. Rating: Ultimate strength at least five times the imposed load.

- D. Submit for structural review pipe hanger locations, point loads and structural attachment details for pipes 6" and larger.
- E. Coordinate installation so that attachments to structure are made prior to fireproofing. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary. Fireproofing material shall match existing.
- F. Where point loads, imposed by work of Division 23, are greater than can safely be carried by the roof or deck, provide structural steel spreader beams tied to the building structure. Submit details of such spreader beams for approval.
- G. Inserts:
  - 1. Furnish inserts to Division 03 Sections – Concrete and Concrete Forming for placement in concrete form work.
  - 2. Furnish inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Furnish hooked rod to Division 03 Sections – Concrete and Concrete Forming for inserts carrying pipe larger than 4 inches.
  - 4. Where concrete slabs form finished ceiling, furnish inserts to be flush with slab surface.
  - 5. Where inserts are omitted, submit an attachment plan to the Owner's Representative.

### **3.02 SUPPORTS, BRACING, AND ACCESSORIES**

- A. Common support systems: This Section is responsible for the provision, coordination, calculations, and seismic bracing of support systems common to Division 23 work. Individual section shall provide their own horizontal support struts. Division 23 shall coordinate with other divisions of all aspects of hanger installation, horizontal strut installation, pipe/conduit/cable tray/etc. installation, seismic bracing installation, and so on.
- B. Set machines and devices dead level, except where pitch or slope is specified or shown. Securely fasten to the structure unless shown otherwise. Use dry pack cement grout to obtain complete contact between structure and equipment.
- C. This Section is responsible for the concrete work for the support of equipment provided by this Section. Coordinate locations with anchor bolts before concrete is placed.
- D. Pipe Hangers and Supports:

1. Support horizontal piping as follows:

Pipe Size	Maximum Hanger Spacing	Hanger Diameter
1/2 to 1-1/4 inch	6 feet 6 inches	3/8 inch
1-1/2 to 2-inch	10 feet	3/8 inch
2-1/2 to 3-inch	10 feet	1/2 inch
4 to 6-inch	10 feet	5/8 inch
PVC (All sizes)	6 feet	3/8 inch
C.I. Bell and Spigot (or No-Hub)	5 feet at joints	3/8 inch

2. Install hangers to provide at least 1/2 inch space between finished covering and adjacent work.
3. Place a hanger within 12 inches of each horizontal elbow.
4. Use hangers with at least 1-1/2 inch vertical adjustment.
5. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
6. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Use specified pipe shields (if applicable). Trapeze size, and support size and spacing shall be governed by the cumulative weight of the supported piping. Maximum trapeze deflection shall be 1/240th of the span on a maximum stress of 15,000 psi, whichever is more stringent.
8. Support riser piping independently of connected horizontal piping.
9. Brace piping longitudinally and transversely as specified and indicated on the drawings. Design of the seismic bracing shall be in accordance with Section 01 73 23 – Seismic Anchorage and Bracing.
10. Support pipe from the building structure so that there is no apparent deflection in pipe runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Do not support from, or brace to, ducts, other pipes, conduit, or materials except building structure. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape, plastic ties, or blocking of any kind. Vertical piping running between floors shall be additionally supported at mid points in a rigid and immobile

fashion. Exposed or concealed piping which can be physically moved, and which is not properly supported will not be accepted, and additional support or bracing will be required. Install seismic bracing as at locations as specified in the contract drawings.

11. Install and secure equipment with anchors and braces to floors, structural members and walls with sufficient backing, to prevent vibration and/or horizontal displacement under load and seismic force as hereinbefore specified. Follow manufacturer's recommendations for the installation of vibration isolators where required for equipment requiring such.

E. Equipment Bases and Supports:

1. Comply with Division 03 Sections – Concrete and Concrete Forming for concrete bases.
2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
3. Construct support of steel members. Brace and fasten with flanges bolted to structure. Level equipment installed on steel rails using shims to compensate for the deflection of the steel.
4. Provide rigid anchors for pipes after vibration-isolation components are installed.

F. Counter Flashing:

1. See Architectural Drawings for flashings.
2. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
3. Counterflash vent and soil pipes projecting at least 3 inches above finished roof surface with lead worked at least 1 inch into hub, at least 8 inches clear on sides using 24 inches by 24 inches sheets. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
4. Counterflash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides using at least 36 inches by 36 inches sheets. Fasten flashing to drain clamp device.
5. Seal floor, shower, mop sink, and drains watertight to adjacent materials.
6. Provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

7. Provide curbs for mechanical roof installations at least 14 inches high above roofing surface. Counterflash with flexible sheet and counterflash with sheet metal; seal watertight.

G. Sleeves:

1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.
3. Where piping or ductwork penetrates floor, ceiling, or wall, close-off space between pipe or duct and adjacent work with fire-stopping insulation and caulk airtight. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
4. Install chrome-plated steel escutcheons at finished surfaces.

### 3.03 SEISMIC RESTRAINTS

- A. Provide support hanger system, equipment, ductwork and piping with seismic restraints in accordance with Section 01 73 23 – Seismic Anchorage and Bracing.
- B. Pipe seismic restraints shall not interfere with pipe thermal expansion loop action or pipe building joint expansion loop action.

**END OF SECTION**

**SECTION 23 05 48**  
**VIBRATION AND SEISMIC CONTROLS FOR HVAC AND PLUMBING**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Section 00 72 00 – General Conditions and Division 01 – General Requirements, apply to this Section.
- B. Section 01 73 23 – Seismic Anchorage and Bracing
- C. Section 05 05 23 – Metal Fastening

**1.02 SUMMARY**

- A. This Section includes the following:
  - 1. Isolation pads.
  - 2. Isolation mounts.
  - 3. Restrained elastomeric isolation mounts.
  - 4. Restrained spring isolators.
  - 5. Housed spring mounts.
  - 6. Elastomeric hangers.
  - 7. Spring hangers.
  - 8. Spring hangers with vertical-limit stops.
  - 9. Pipe riser resilient supports.
  - 10. Resilient pipe guides.
  - 11. Seismic snubbers.
  - 12. Restrained vibration isolation roof-curb rails.
  - 13. Restraining braces and cables.

**1.03 DEFINITIONS**

- A. IBC: International Building Code.



- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.
- D. ASCE 7: Minimum Design Loads for Buildings and Other Structures
- E. SMACNA Seismic Restraint Manual: Guidelines for Mechanical Equipment

**1.04 PERFORMANCE REQUIREMENTS**

- A. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: See Drawing S01.
  - 2. Seismic Design Category: See Drawing S01.
  - 3. Assigned Building Occupancy/Risk Category as Defined in the IBC: See Drawing S01.
    - a. Component Importance Factor ( $I_p$ ): 1.0.
    - b. Component Response Modification Factor ( $R_p$ ): Per the following table\*:
    - c. Component Amplification Factor ( $a_p$ ): Per the following table\*:

Mechanical Component or Element	Component Amplification Factor ( $a_p$ )	Component Response Modification Factor ( $R_p$ )
Air-side HVAC fans, air handling units, AC units, and terminal units with sheet metal cabinets	2.5	6.0
Piping per ASME B31, welded or brazed joints	2.5	12.0
Piping per ASME B31, threaded, compression coupled or grooved coupling joints	2.5	6.0
Sheet metal Ductwork, including inline components with joints made by welding or brazing	2.5	9.0
Sheet metal Ductwork, including inline components with joints made other than by welding or brazing	2.5	6.0

- 4. \*Refer to most recent version of ASCE 7 tables (Chapter 13 or 15) on component seismic coefficients as governing authority on values shown above and components not listed in table above.
- 5. Design Spectral Response Acceleration at Short Periods (0.2 Second): See Drawing S01.
- 6. Design Spectral Response Acceleration at 1-Second Period: See Drawing S01.

## 1.05 SUBMITTALS

- A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer licensed in the State or Commonwealth in which the project is located and responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases. Provide support reactions.
  2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
  3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
  4. Seismic-Restraint Details:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    - c. Pre-approval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Qualification Data: For professional engineer and testing agency.

## 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel" for carbon steel, AWS D1.2/D1.2M for aluminum, or AWS D1.6 for stainless steel materials.
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Submittals without the seal of a qualified registered professional engineer's stamp will be rejected without review and returned for re-submission.

## PART 2 – PRODUCTS

### 2.01 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ace Mountings Co., Inc.
  - 2. Amber/Booth Company, Inc.
  - 3. Cooper B-Line.
  - 4. Isolation Technology, Inc.
  - 5. Kinetics Noise Control.
  - 6. Mason Industries.
  - 7. Vibration Eliminator Co., Inc.

8. Vibration Isolation.
  9. Vibration Mountings & Controls, Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene, rubber or hermetically sealed compressed fiberglass.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts: All-directional mountings with seismic restraint.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
  2. Base: Factory drilled for bolting to structure.
  3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.
- G. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- I. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
- K. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.02 VIBRATION ISOLATION EQUIPMENT BASES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Amber/Booth Company, Inc.
  2. Cooper B-Line.
  3. Isolation Technology, Inc.

4. Kinetics Noise Control.
  5. Mason Industries.
  6. Vibration Eliminator Co., Inc.
  7. Vibration Isolation.
  8. Vibration Mountings & Controls, Inc.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base (refer to drawing details for equipment requiring inertia bases): Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

### 2.03 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Amber/Booth Company, Inc.
  2. California Dynamics Corporation.
  3. Cooper B-Line, Inc.; a division of Cooper Industries.
  4. Hilti, Inc.
  5. Kinetics Noise Control.
  6. Loos & Co.; Cableware Division.
  7. Mason Industries.
  8. TOLCO Incorporated; a brand of NIBCO INC.
  9. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction. If the authorities having jurisdiction do not list an agency, at a minimum use an evaluation service member of ICC-ES or OSHPD.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end



and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## **2.04 FACTORY FINISHES**

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  - 1. Powder coating on springs and housings.
  - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  - 3. Baked enamel or powder coat for metal components on isolators for interior use.
  - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 APPLICATIONS**

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction. If the authorities having jurisdiction do not list an agency, at a minimum use an evaluation service member of ICC-ES or OSHPD.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### **3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION**

- A. Comply with requirements in Section 07 70 00 – Roof Specialties and Accessories for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
  - 1. Install seismic snubbers on mechanical equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches (3.2 mm).
  - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction. If the authorities having jurisdiction do not list an agency, at a minimum use an evaluation service member of ICC-ES or OSHPD, providing required submittals for component.
- C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
  2. Space lateral supports a maximum of 30 feet on center, and longitudinal supports a maximum of 60 feet on center.
  3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction. If the authorities having jurisdiction do not list an agency, at a minimum use an evaluation service member of ICC-ES or OSHPD, providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Drilled-in Anchors:
1. Refer to specification Section 05 05 23 – Metal Fastening.
  2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

### **3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION**

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 22 11 13 – Facility Water Distribution Piping and Section 23 21 14 – Building Services Piping for piping flexible connections.

### **3.05 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.

**C. Tests and Inspections:**

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Owner's Representative, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Owner's Representative approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Where nonstructural component seismic certifications as required by Section 01 73 23 – Seismic Anchorage and Bracing and Section 32 05 48 – Vibration and Seismic Controls for HVAC provide manufacturer's certification and installation guidelines.
5. Test at least four of each type and size of installed anchors and fasteners selected by Owner's Representative.
6. Test to 90 percent of rated proof load of device and anchorage.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

**3.06 ADJUSTING**

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

10/17/2024

**3.07 MECHANICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE  
SCHEDULE**

- A. Supported or Suspended Equipment: <Insert name or unit tag; example. [HVAC-1].
  - 1. Pads:
    - a. Material: [Neoprene] [Rubber] [Hermetically sealed compressed fiberglass].
    - b. Thickness: <Insert inches (mm)>.
    - c. Number of Pads: <Insert number> thick.
  - 2. Isolator Type: <Insert generic name or designation used in Part 2>.
  - 3. Base Type: <Insert generic name or designation used in Part 2>.
  - 4. Minimum Deflection: <Insert inches (mm)>.
  - 5. Component Importance Factor: Refer to Part 1.
  - 6. Component Response Modification Factor: Refer to Part 1.
  - 7. Component Amplification Factor: Refer to Part 1.

**END OF SECTION**

**SECTION 23 05 53****IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND  
EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Work Included:
  - 1. Plastic Nameplates
  - 2. Tags
  - 3. Plastic Pipe Markers
  - 4. Detectable Underground Tape
  - 5. Stencils

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.
- B. Plastic Nameplates:
  - 1. Brady Corporation
  - 2. Brimar
  - 3. Champion America
  - 4. Craftmark
  - 5. Seton
  - 6. Or approved equivalent.
- C. Tags:
  - 1. Brady Corporation
  - 2. Brimar
  - 3. Champion America
  - 4. Craftmark
  - 5. Seton
  - 6. Or approved equivalent.
- D. Plastic Pipe Markers:
  - 1. Brady Corporation
  - 2. Brimar
  - 3. Champion America
  - 4. Craftmark
  - 5. Seton

6. Or approved equivalent.
- E. Detectable Underground Tape:
1. Brady Corporation
  2. Brimar
  3. Champion America
  4. Craftmark
  5. Seton
  6. Or approved equivalent.
- F. Stencils:
1. Brady Corporation
  2. Brimar
  3. Champion America
  4. Craftmark
  5. Seton
  6. Or approved equivalent.

## 2.2 PLASTIC NAMEPLATES

- A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
1. Letter Color: White.
  2. Letter Height: 1/2-inch.
  3. Background Color: Black.
  4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
  5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

## 2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 2-inch diameter.
- B. Metal Tags: Polished Brass with stamped letters; tag size minimum 2-inch diameter with smooth edges.
- C. Valve designations to be coordinated with existing valve identifications to ensure no repetitive designations are utilized.
- D. Chart/Schedules: Valve Schedule Frames. For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

- E. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.
- F. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
  - 1. Size: Approximately 4 by 7-inches.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
  - 4. Color: Yellow background with black lettering.

## 2.4 PLASTIC PIPE MARKERS

- A. Color: Conform to ASME A13.1 and ANSI Z535.1.
- B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Lettering:
  - 1. 3/4-inch to 1-1/4-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 1/2-inch high letters.
  - 2. 1-1/2-inch to 2-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 3/4-inch high letters.
  - 3. 2-1/2-inch to 6-inch Outside Diameter of Insulation or Pipe: 12-inch long color field, 1-1/4-inch high letters.
  - 4. 8-inch to 10-inch Outside Diameter of Insulation or Pipe: 24-inch long color field, 2-1/2-inch high letters.
  - 5. Over 10-inch Outside Diameter of Insulation or Pipe: 32-inch long color field, 3-1/2-inch high letters.

## 2.5 DETECTABLE UNDERGROUND TAPE

- A. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape with aluminum backing, minimum 6-inches wide by 4 mil thick, manufactured for direct burial service. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

## 2.6 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
  - 1. 3/4-inch to 1-1/4-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 1/2-inch high letters.
  - 2. 1-1/2-inch to 2-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 3/4-inch high letters.



3. 2-1/2-inch to 6-inch Outside Diameter of Insulation or Pipe: 12-inch long color field, 1-1/4- inch high letters.
  4. 8-inch to 10-inch Outside Diameter of Insulation or Pipe: 24-inch long color field, 2-1/2- inch high letters.
  5. Over 10-inch Outside Diameter of Insulation or Pipe: 32-inch long color field, 3-1/2-inch high letters.
  6. Equipment: 2-1/2-inch high letters.
  7. Direction Arrows: Show flow direction.
- B. Stencil Paint: As specified in Division 9, Finishes, semi-gloss enamel, colors conforming to ASME A13.1.

## **PART 3 - EXECUTION**

### **3.1 GENERAL - INSTALLATION**

- A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.
- B. Identify ductwork with plastic ductmarkers.
- C. Identify piping, concealed or exposed, with stencilled painting.
- D. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).
- F. Degrease and clean surfaces to receive adhesive for identification materials.
- G. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- H. Coordinate with the facility maintenance personnel to ensure consistency with the existing tagging system.
- I. Install all products in accordance with manufacturer's instructions.
- J. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

### **3.2 PLASTIC NAMEPLATES**

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.
- B. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.
- C. Identify thermostats with nameplates.

### **3.3 TAGS**

- A. Use metal tags on piping 3/4-inch diameter and smaller.
- B. Tag balancing valves and major dampers with balanced GPM or CFM indicated after balancing is completed and accepted.
- C. Install tags with corrosion resistant chain.
- D. Small devices, such as in-line pumps, may be identified with tags.
- E. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.
- F. Identify air terminal units and radiator valves with numbered plastic tags.
- G. Tag automatic controls, instruments, and relays. Key to control schematic.
- H. Install valve schedule at each mechanical room.

### **3.4 PLASTIC PIPE MARKERS**

- A. Install plastic pipe markers complete around pipe in accordance with manufacturer's instructions.
- B. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

### **3.5 DETECTABLE UNDERGROUND TAPE**

- A. For underground piping installations, Install underground plastic pipe markers with tracer wire 6- inches to 8-inches below finished grade, directly above buried pipe.

### **3.6 STENCILS**

- A. Prepare surfaces for stencil painting.
- B. Follow manufacturer's instructions for paint used for stencils.

## **END OF SECTION**

**SECTION 23 05 93**  
**HVAC BALANCING**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.

**1.03 DEFINITIONS**

- A. AABC – Associated Air Balance Council.
- B. Adjust – To regulate fluid flow rates and air patterns at the system or terminal level. At the system level an example would be reducing fan speed; at the terminal level an example would be changing a damper position.
- C. Balance – To proportion air or water flows within the distribution system, including submains, branches and terminals with respect to design quantities.
- D. Draft – A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. Independent – Not affiliated with or in employment of any Contractor.
- F. NEBB – National Environmental Balancing Bureau.
- G. Procedure – An approach to and execution of a sequence of work operations to yield repeatable results.
- H. Report Forms – Data sheets for recording data in logical order.

- I. Static Head – The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head – The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect – A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors – Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TABB – Testing, Adjusting, and Balancing Bureau
- N. Balancing Specialist – An entity engaged to perform balancing work.
- O. Balancing Agent –The entity responsible for performing and reporting the balancing procedures.
- P. Terminal – A point where the controlled medium (fluid or energy) enters or leaves the distribution system.

#### **1.04 RELATED SECTIONS**

- A. Section 01 33 00 – Submittal Procedures
- B. Section 23 00 00 – Basic HVAC Requirements
- C. Section 23 05 48 – Vibration and Seismic Control for HVAC
- D. Section 23 05 95 – HVAC Field Testing
- E. Section 23 07 00 – HVAC Insulation
- F. Section 23 08 00 – Commissioning of HVAC Systems
- G. Section 23 09 00 – HVAC Automatic Temperature Controls
- H.
- I. Section 23 31 13 – Metal Ducts and Duct Accessories
- J. Section 23 34 00 – HVAC Fans

K. Section 23 75 00 – Custom-Packaged HVAC Equipment

**1.05 PROCEDURES**

- A. Testing and balancing of the equipment and systems of the facility shall be performed in the following order:
1. Equipment Checkout (See Specification 23 05 95 – HVAC Field Testing for testing requirements)
  2. Equipment Testing (See Specification 23 05 95 – HVAC Field Testing for testing requirements)
  3. Balancing (See Specifications 23 05 93 – HVAC Balancing for balancing requirements).
  4. System Testing (See Specification 23 05 95 – HVAC Field Testing for testing requirements)
- B. Balancing shall not be started until the Contractor has submitted and received approval on the Equipment Checkout and Equipment Testing of the respective equipment for the system being balanced.
- C. Certified Data. The Contractor shall provide the Agency with the certified data on pumps, chillers and other equipment required for proper balancing of the system.
- D. Adjustment. The Agency shall supervise or perform necessary adjustments to valves, pumps and other controls as required to properly balance the system.
- E. Balancing. The Agency shall follow balancing procedures published by the AABC, or NEBB.
- F. Reports: Compile the data on report forms as listed in the AABC "National Standards for Total System Balance".

**1.06 SUBMITTALS**

- A. NOT USED

**1.07 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the Balancing specialist and this Project's Balancing team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.0.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit Balancing strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified Balancing reports: Within 21 days of completion of balancing work, submit AABC-certified Balancing report.
- G. Submit one copy of the final Balancing Report directly to the design professional of record. Provide five additional copies to the contractor
- H. Sample report forms.
- I. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### **1.08 QUALITY ASSURANCE**

- A. Refer to Articles, Quality Assurance and Submittals in Section 23 00 00 – Basic HVAC Requirements and Section 23 08 00 – Commissioning of HVAC Systems.
- B. Qualifications:
  - 1. Balancing Agency: The Balancing agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The Balancing agency shall be either a certified member of AABC, TABB, or NEBB to perform Balancing services for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire

duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another Balancing firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the Balancing. All work performed in this Section and in other related Sections by the Balancing agency shall be considered invalid if the Balancing agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.

3. **Balancing Specialist:** The Balancing specialist shall be either a member and certified member of AABC, TABB, or NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another Balancing Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, TABB, or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including Balancing. All work specified in this Section and in other related Sections performed by the Balancing specialist shall be considered invalid if the Balancing Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. Balancing Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The Balancing specialist will be coordinating, scheduling and reporting all Balancing work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
  - a. Shall directly supervise all Balancing work.
  - b. Shall sign the Balancing reports that bear the seal of the Balancing standard. The reports shall be accompanied by report forms and schematic drawings required by the Balancing standard, AABC, TABB, or NEBB.
  - c. Would follow all Balancing work through its satisfactory completion.
  - d. Shall provide final permanent markings of settings of all HVAC adjustment devices.
  - e. Permanently mark location of duct test ports.
5. All Balancing technicians performing actual Balancing work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in

size and complexity to this project. Qualifications must be certified by the Balancing agency in writing. The lead technician shall be certified by AABC, TABB, or NEBB

- C. Balancing Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for balancing purpose.
- D. Balancing Criteria:
1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 38, and requirements stated herein shall be the basis for planning, procedures, and reports.
  2. Flow rate tolerance: The following tolerances are allowed. All tolerances are based on the design flowrates listed in the contract documents. For tolerances not mentioned herein follow 2011 ASHRAE Handbook "HVAC Applications", Chapter 38, as a guideline. Air Filter resistance during balancing, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
    - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
    - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
    - c. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
    - d. Minimum outside air: 0 percent to plus 10 percent.
    - e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
    - f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 10 percent.
    - g. Chilled water and condenser water pumps: Minus 0 percent to plus 10 percent.
    - h. Chilled water coils: Minus 0 percent to plus 10 percent.
  3. Systems shall be adjusted for energy efficient operation as described in PART 3.



4. Typical Balancing procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Resident Engineer) and one hydronic system (pumps and three coils) as follows:
  - a. When field Balancing work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by Owner's Representative.
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 – Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 – System Balancing.

#### **1.09 FIELD CONDITIONS**

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire Balancing period. Cooperate with Owner during Balancing operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during Balancing operations to minimize conflicts with Owner's operations.

#### **1.10 WARRANTY**

- A. Provide one of the following performance guarantees:
  1. AABC National Project Performance Guarantee
  2. NEBB Certificate of Conformance Certification
  3. Balancing Quality Assurance Program Guarantee
  4. TABB Project Performance Guarantee
- B. Guarantee shall include provisions that the certified Balancing firm has balanced systems according to the Contract Document and that the systems are balanced to optimum performance capabilities within design and installation limits.

## **PART 2 – PRODUCTS**

### **2.01 INSTRUMENT TEST HOLES**

- A. Permanent Test holes covers to be Ventlock #699.
- B. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

## **2.02 INSULATION REPAIR MATERIAL**

- A. See Section 23 07 00 – HVAC Insulation. Provide for repair of insulation removed or damaged for Balancing work.

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper balancing of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for balancing.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- E. Examine equipment performance data including fan and pump curves.
- F. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and equipment with functioning controls is ready for operation.
- G. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor, and functioning.
- H. Examine strainers to verify that mechanical contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.
- I. Examine two-way valves for proper installation and function.
- J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

### **3.02 PREPARATION**

- A. Prepare a Balancing plan that includes the following:
  - 1. Equipment and systems to be balanced.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Prepare system-readiness checklists, as described in the "AABC National Standards for Total System Balance," for use by systems installers in verifying system readiness for Balancing. These shall include, at a minimum, the following:
  - 1. Airside:
    - a. Ductwork is complete with terminals installed.
    - b. Volume, smoke and fire dampers are open and functional.
    - c. Clean filters are installed.
    - d. Fans are operating, free of vibration, and rotating in correct direction.
    - e. Variable-frequency controllers' start-up is complete and safeties are verified.
    - f. Automatic temperature-control systems are operational.
    - g. Ceilings are installed.
    - h. Windows and doors are installed.
    - i. Suitable access to balancing devices and equipment is provided.

### **3.03 GENERAL PROCEDURES FOR BALANCING**

- A. Perform balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

1. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for balancing procedures.
2. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
3. Adjust fan speeds by maximizing adjustable sheaves and pump impeller speeds if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, notify the Resident Engineer.
4. Take report balancing measurements in inch-pound (IP) units.

### **3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**

- A. Prepare balancing reports for both fans and outlets. Obtain approved submittals and recommended balancing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check condensate drains for proper connections and functioning.
- H. Check for proper sealing of air-handling-unit components.

### **3.06 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS**

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  1. Measure total airflow.
    - a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.

- b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report any artificial loading of filters at the time static pressures are measured.
  3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
  2. Adjust sub-main and branch duct volume dampers for specified airflow. Re-measure each sub-main and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure airflow at all inlets and outlets.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after all have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, static profile.
4. Mark all final settings.
5. Run system in economizer mode. Verify proper operation and adjust, if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

### 3.07 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located 2/3 of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control setpoint so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows
  - a. Adjust controls so that terminal is calling for maximum airflow (note some controllers require starting with minimum airflow. Verify calibration procedure for specific project).
  - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
  - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.

- d. Adjust controls so that terminal is calling for minimum airflow.
  - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
  - f. When in full cooling or full heating, ensure that there is no mixing of hot deck and cold deck airstreams unless so designed.
  - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After all terminals have been calibrated and balanced, adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
- a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
- a. Measure static pressure directly at the fan outlet or through the flexible connection.
  - b. Measure static pressure directly at the fan inlet or through the flexible connection.
  - c. Measure static pressure across each component that makes up the air-handling system.

- d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    - b. Verify all terminal units are meeting design airflow under system maximum flow.
  8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure setpoint to the most energy-efficient setpoint to maintain the optimum system static pressure. Record setpoint and give to controls contractor.
  9. Verify final system conditions as follows:
    - a. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.
    - b. Re-measure and confirm total airflow is within design.
    - c. Re-measure all final fan operating data, rpms, volts, amps, static profile.
    - d. Mark all final settings.
    - e. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.
    - f. Verify tracking between supply and return fans.

### **3.08 PROCEDURES FOR MOTORS**

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase/Hertz (Hz)
  5. Nameplate and measured voltage, each phase.



6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test the manual bypass of the controller to prove proper operation.

### **3.09 PROCEDURES FOR BALANCING EXISTING SYSTEMS**

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
  2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  3. Check the condition of filters.
  4. Check the condition of coils.
  5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
  2. Coils are clean and fins combed.
  3. Drain pans are clean.
  4. Fans are clean.
  5. Deficiencies noted in the preconstruction report are corrected.
- C. Perform balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed.

2. Verify that the indicated airflows of the renovated work result in fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. Adjust fan speeds within the limits of the installed sheaves and belts to achieve design airflow.
4. Balance system to design airflows indicated.

### **3.10 TOLERANCES**

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
  3. Heating-Water Flow Rate: Plus or minus 10 percent.
  4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### **3.11 FINAL BALANCE REPORT**

- A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the balancing process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and results that appear in the reports must be made on site and dated by the AABC technicians or balancing engineers.
- B. The report must be organized by systems and shall include the following information as a minimum:
  1. Title Page:
    - a. AABC, TABB, or NEBB certified company name
    - b. Company address
    - c. Company telephone number
    - d. Project identification number
    - e. Location

- f. Project Architect
  - g. Project Engineer
  - h. Project Contractor
  - i. Project number
  - j. Date of report
  - k. AABC or NEBB Certification Statement
  - l. Name, signature, and certification number of AABC, TABB, or NEBB
2. Table of Contents.
  3. AABC National Performance Guaranty.
  4. Report Summary:
    - a. The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
  5. Instrument List:
    - a. Type.
    - b. Manufacturer.
    - c. Model.
    - d. Serial Number.
    - e. Calibration Date.
  6. Balancing Data:
    - a. Provide data for specific systems and equipment as required by the most recent edition of the "AABC National Standards."
- C. One copy of the final balancing report shall be sent directly to the design professional of record. Provide five additional copies to the contractor.

### **3.12 VERIFICATION OF BALANCING REPORT**

- A. Final Verification:

1. After balancing is complete and accurately documented in the final report, request that a final verification be made by design professional
2. The Balancing Agency shall conduct the verification in the presence of design professional.
3. Design Professional shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final verification, the balancing shall be considered incomplete.

### **3.13 REVERIFICATION**

- A. Balancing Agency shall recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second verification.
- B. If the second verification also fails, Owner may contact the applicable certification bureau.

### **3.14 ADDITIONAL BALANCING REQUIREMENTS**

- A. Seasonal Periods: If initial balancing procedures were not performed during near-peak conditions, the engineer may request a temperature recheck to further verify performance at near-peak conditions.
- B. Vibration Testing:
  1. After the systems are balanced and the spaces are architecturally complete, read and record vibration levels on all equipment with motor horsepower equal to or greater than 10 hp.
  2. Instrumentation:
    - a. The vibration meter should be portable, battery-operated, and microprocessor-controlled, with or without a built-in printer.

- b. The meter shall automatically identify engineering units, filter bandwidth, amplitude and frequency scale values.
  - c. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
3. Test Procedures:
- a. Verify that the vibration meter calibration date is current before taking readings.
  - b. To ensure accurate readings, verify that the accelerometer has a clean, flat surface and is mounted properly.
  - c. With the unit running, set up the vibration meter in a safe, secure location. Connect the transducer to the meter with the proper cables. Hold the magnetic tip of the transducer on top of the bearing, and measure the unit in mils of deflection. Record the measurement, then move the transducer to the side of the bearing, and record in mils of deflection. Record an axial reading in mils of deflection by holding the nonmagnetic, pointed transducer tip on the end of the shaft.
  - d. Change the vibration meter to velocity (inches per second) measurements. Repeat and record the above measurements.
  - e. Record the CPM or the RPM.
  - f. Read each bearing on the motor, fan, and/or pump as required. Track and record vibration levels from the rotating component through the casing to the base.
4. Reporting
- a. The report must record the location and the system tested.
  - b. Include horizontal-vertical-axial measurements for all tests.
  - c. Verify that vibration limits follow specifications, or, if not specified, follow the "General Machinery Vibration Severity Chart" or "Vibration Acceleration General Severity Chart" from the AABC National Standards. Acceptable levels of vibration are normally "Smooth" to "Good."
  - d. Include in the report the Machinery Vibration Severity Chart, with conditions plotted.

### C. Controls Verification

1. In conjunction with system balancing perform the following:
  - a. Work with the Automatic Temperature Control (ATC) contractor to ensure the system is operating within the design limitations, and gain a mutual understanding of intended control performance.
  - b. Confirm that the sequences of operation are in compliance with the approved drawings.
  - c. Verify that instruments and devices are calibrated and function as intended.
  - d. Verify that controller setpoints are as specified. Provide setpoints to ATC Contractor where required by the strategies such as fan/pump speeds and modulating damper positions to achieve design flows.
  - e. Verify the operation of all valve and damper actuators.
  - f. Verify that all controlled devices are properly installed.
  - g. Verify that all controlled devices travel freely and are in the position indicated by the controller: open, closed, or modulating.
  - h. Verify the location and installation of all sensors to ensure they will sense only the intended temperatures, humidities, or pressures.
2. Reporting
  - a. The report shall include a summary of verifications performed, remaining deficiencies, and any variations from specified conditions

**END OF SECTION**

**SECTION 23 05 95**  
**HVAC FIELD TESTING**

**PART 1 – GENERAL**

**1.01 REQUIREMENTS**

- A. The requirements of this Section apply to all sections of Division 23.
- B. This Section specifies the requirements and procedures for field testing the HVAC systems. Requirements include developing a detailed testing plan and executing the testing plan to meet design requirements as indicated in this specification. Actions include but are not limited to measurement of the fluid quantities of the HVAC systems, operating HVAC equipment, proving control strategy requirements, and adjustments to meet control strategy requirements.
- C. The testing and balancing of the equipment and systems of the facility shall be performed in the following order:
  - 1. Equipment Checkout – Physical Checkout
  - 2. Equipment Testing – Short Run Test
  - 3. Balancing (See Section 23 05 93 – HVAC Balancing for balancing requirements)
  - 4. System Testing – Full Controls Test and Control Strategy Proving
  - 5. Commissioning – (See Section 23 08 00 – HVAC Commissioning for commissioning requirements.)
- D. The Contractor shall submit and obtain approval for the Equipment Checkout and Equipment Testing prior to beginning balancing.
- E. The Contractor shall submit and obtain approval for the HVAC System Balancing prior to beginning the System Test.
- F. Where a system consists of multiple pieces of equipment (i.e., air handler and exhaust fans, etc.), all parts of the system shall have their Equipment Checkout and Equipment Testing submitted and approved before Balancing begins. Similarly, Balancing shall be completed, submitted, and approved for all system components before System Testing can begin.

1. Where this action would be deleterious or prohibitive to the system or component parts, the Contractor shall specifically include the reason in the Testing Procedure submittal and receive approval.
- G. The following HVAC systems shall be field tested:
1. Air Handling Equipment including integral and external fans
  2. Air Cooling Systems
  3. Air Heating Systems
  4. Air Conveying Systems
- H. This Section does not include specifications for materials for patching HVAC systems, or specifications for materials and installation of temporary devices. If devices must be added to achieve proper system testing or to execute the system control strategy, they shall be provided.
- I. The respective equipment manufacturer's representative shall be present for Equipment Checkout and Equipment Testing activities. The representative shall sign all testing reports related to these portions of the testing report.

## 1.02 DEFINITIONS

- A. Systems testing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes the balance of air distribution, water distribution, the adjustment of total system to provide design quantities, the electrical measurement, and the verification of performance of all equipment and automatic controls.
1. Test: To determine quantitative performance of equipment.
  2. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
  3. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
  4. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
  5. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.



6. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets or supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
7. Main: Duct containing the system's major or entire fluid flow.
8. Submain: Duct containing part of the systems' capacity and serving two or more branch mains.
9. Branch Main: Duct serving two or more terminals.
10. Branch: Duct serving a single terminal.

### **1.03 SUBMITTALS**

- A. Submit the following in accordance with Division 1 requirements.
- B. All testing shall be witnessed by the Owner, Owner's representative, or the Resident Engineer.
- C. The Contractor shall submit a detailed testing procedure for approval. The Contractor shall have the testing procedure approved 30 days before testing is scheduled to begin. The detailed testing procedure shall include forms, procedures and diagrams for the Equipment Checkout, Equipment Test, and System Test procedures described in Part 3 of this specification. The testing procedure shall include:
  1. Detailed step by step instructions as to how the equipment tests will be performed including but not limited to temporary layout modifications, any special procedures for testing equipment functionality, and how system actions will be activated.
  2. All testing for systems that require seasonal outside air conditions shall be conducted when outside air conditions are suitable for such testing. When approved by the Engineer, the Contractor may conduct seasonal testing of the system during off-seasonal conditions. When this condition is approved, the report shall indicate how the test will accommodate testing of seasonal systems when seasonal conditions are not present.
  3. A list of any additional or temporary equipment necessary to perform the tests such as pumps, heat exchangers, heating or cooling equipment.
  4. A list of any instruments necessary to verify instrument signals in the HVAC system. The list shall include current calibration information. All instruments shall be within their calibration expiration at the date the testing is performed.

5. Provide tables for recording all required readings, action results, and comments.
  6. Provide a checklist of items that will be checked during the test as listed in relative sections of Part 3 of this specification. Each action or step shall have a separate row. Each action or step shall be initialed by the Contractor's Testing Technician conducting the test. All tests shall be signed and dated by the Contractor, the Testing Technician, and the Owner, Owner's Representative, or Resident Engineer. The Equipment Checkout and Equipment Test shall also be signed by the respective equipment manufacturer's representative.
- D. As each section of the Testing Procedure is completed, the Contractor shall compile and submit all signed results to the Owner for acceptance.
  - E. The equipment manufacturer's representative shall be present for all testing. The Equipment Checkout and Equipment Testing results shall include a letter from the Manufacturer's representative stating that the equipment has been installed per the Manufacturer's installation requirements and is in satisfactory working order.
  - F. Submit proof that the Testing Technician assigned to supervise the procedures, and the individual technicians proposed to perform the procedures meet the qualifications specified below.
  - G. The Contractor shall submit the signed results of the testing to the Owner for acceptance. The equipment manufacturer's representative shall be present for all testing. The results shall include a letter from the Manufacturer's representative stating that the equipment has been installed per the Manufacturer's installation requirements and is in satisfactory working order. Any deficiencies noted by the Manufacturer's representative shall be corrected and testing repeated.
    1. The calibration data for all instruments used to verify HVAC system instrument readings shall be refreshed. All instruments shall be within their calibration expiration at the date the testing was performed.

#### **1.04 QUALITY ASSURANCE**

- A. Testing Personnel Qualifications: The personnel responsible for testing the specified systems shall have at least three years of experience in testing systems similar to this project and shall be an employee of the installer or an independent testing agency.
- B. Codes and Standards:
  1. NEBB, "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

2. ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.
- C. The Contractor shall provide all necessary instrumentation, tools, ladders, and labor etc. to complete all testing activities.
- D. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.
- E. The Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.
- F. The Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

### **1.05 SEQUENCING AND SCHEDULING**

- A. Systems shall be fully operational prior to beginning procedures.

### **1.06 RELATED SECTIONS**

- A. Section 23 00 00 - Basic HVAC Requirements
- B. Section 23 08 00 – Commissioning of HVAC Systems
- C. Section 23 09 00 – HVAC Automatic Temperature Controls
- D. Section 23 34 00 – HVAC Fans
- E. Section 23 31 13 – Metal Ducts and Duct Accessories
- F. Section 23 31 16 – Nonmetal Ducts and Duct Accessories
- G. Section 23 75 00 – Custom Packaged HVAC Equipment

## **PART 2 – PRODUCTS**

## **PART 3 – EXECUTION**

### **3.01 HVAC TESTING SEQUENCING**

- A. The HVAC testing shall be performed in the following sequence.
  1. Pre-Start-up Inspection

2. Equipment Test
3. Balancing (See Section 23 05 93 – HVAC Balancing for balancing requirements)
4. Individual System Test
5. Whole HVAC System Run Test

#### B. HVAC PRE-START-UP INSPECTION AND EQUIPMENT TESTING

1. All HVAC equipment shall have a Pre-Start-up Inspection and Equipment test performed. The specific requirements for equipment indicated below shall be performed in addition to any requirements of the Manufacturer for startup and initial operation. All other equipment shall be inspected per the Manufacturer's requirements and run for 1 hour trouble free.
2. The equipment manufacturer's representative shall be present for all testing.
3. Fans:
  - a. Pre Startup Inspection:
    - 1) Verify proper equipment mounting and setting
    - 2) Verify that control, interlock and power wiring is complete
    - 3) Verify alignment of motors and drives
    - 4) Verify proper belt tension
    - 5) Verify proper duct connections and accessories
    - 6) Verify that lubrication is completed
    - 7) Verify that equipment is in good condition and free from damage
    - 8) Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed
    - 9) Verify that equipment and associated ducts are free from debris
    - 10) Verify that equipment is installed per the Manufacturer's requirements
  - b. Equipment Test:
    - 1) Prior to energizing motor, verify and record voltage of power supply

- 2) Bump motor to verify direction of rotation
- 3) Run the fan for 1 hour of continuous trouble free operation. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure.
- 4) Monitor heat build-up in bearings. Bearing temperature shall not exceed the manufacturer's recommendations.
- 5) Monitor for any abnormal noises or vibration. Abnormal noises and vibration shall be assessed and determined by the equipment manufacturer's representative.
- 6) Check motor loads against nameplate data
- 7) Record fan sound levels ten (10) feet from the surface of the fan in five (5) minute intervals during 1 hour run period. Sound levels shall be below 90 dB at all times.

#### C. Cooling Equipment (Refrigerant based)

##### 1. Pre Startup Inspection:

- a. Verify proper equipment mounting and setting
- b. Verify that control, interlock and power wiring is complete
- c. Verify proper duct connections and accessories
- d. Verify that lubrication is completed
- e. Verify that equipment is in good condition and free from damage
- f. Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed
- g. Verify that equipment and associated ducts are free from debris
- h. Verify that the refrigeration system has been evacuated and charged per the Manufacturer's requirements
- i. Verify that equipment is installed per the Manufacturer's requirements

##### 2. Equipment Test:

- a. Prior to energizing unit, verify and record voltage of power supply

- b. Run the unit for 1 hour of continuous trouble free operation, with no unexpected shutdowns, alarms or operational issues. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure. If the ambient air temperature is too low to have the refrigeration system running constantly for 1 hour, the Contractor shall take into account any additional measures required to accomplish the testing based on the ambient air temperature. The Contractor shall provide any temporary heating equipment required to run this test including but not limited to temporary fans, ductwork, heaters, generators, heat exchangers, combustion equipment, and fuel storage and pumping at no cost to the project. Use of any heating equipment that was installed as part of this work shall not be permitted to be used as a heat source.
  - c. Monitor discharge and return air temperatures and compare to the manufacturer's submitted values.
  - d. Monitor for any abnormal noises or vibration. Abnormal noises and vibration shall be assessed and determined by the equipment manufacturer's representative.
  - e. Record fan sound levels ten (10) feet from the surface of the equipment in five (5) minute intervals during 1 hour run period. The sound levels shall not exceed 90 dB.
3. Air Handling Units (Heating)
- a. Pre Startup Inspection:
    - 1) Verify proper equipment mounting and setting
    - 2) Verify that control, interlock and power wiring is complete
    - 3) Verify alignment of motors and drives
    - 4) Verify proper belt tension
    - 5) Verify proper duct connections and accessories
    - 6) Verify that lubrication is completed
    - 7) Verify that equipment is in good condition and free from damage
    - 8) Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed

- 9) Verify that equipment and associated ducts are free from debris
- 10) Verify that equipment is installed per the Manufacturer's requirements

4. Equipment Test:

- a. Prior to energizing unit, verify and record voltage of power supply
- b. Run the unit for 1 hour of continuous trouble free operation with no unexpected shutdowns, alarms or operational issues in heating mode and for 1 hour of continuous trouble free operation in ventilating mode. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of the respective 1 hour test. Any safety trips will cause this testing to be restarted from the beginning of this procedure. If the ambient air temperature is too high to have the unit heating constantly for 1 hour, the Contractor shall adjust the setpoint temperature of the unit. The Contractor shall coordinate this testing with all other trades. The Contractor is responsible for scheduling this testing and shall take into account any additional measures required to accomplish the testing based on the ambient air temperature. The Contractor shall not raise the temperature in the space to a point where it will cause damage to any equipment in the space or create unsafe or uncomfortable working conditions for the workers as determined by the Owner. If the Owner determines that the ambient conditions will not allow the testing of this equipment because the Contractor has scheduled the testing for a point in the season known to be warm, the Contractor shall provide any temporary cooling required to run this test including but not limited to temporary fans, ductwork, chillers, generators, cooling towers, make-up water supplies, heat exchangers, or air conditioners at no additional cost to the project.
- c. Monitor heat build-up in bearings. Temperature shall not exceed the manufacturer's recommendations.
- d. Monitor for any abnormal noises or vibration. Abnormal noises and vibration shall be assessed and determined by the equipment manufacturer's representative.
- e. Check unit loads against nameplate data
- f. Record fan sound levels ten (10) feet from the surface of the fan in five (5) minute intervals during both 1 hour continuous operating periods.

D. Drip Pans

1. Drip pans and drains shall be hydrostatically tested under gravity of a filled drip pan and drain line for a minimum of 30 minutes. Any leaks shall be corrected, and the drip pan/drains retested until a watertight drip pan drainage system is confirmed.

E. Ductwork

1. All openings in the ductwork shall be temporarily sealed and the ductwork shall be pressurized and leak tested to demonstrate that the installation meets the specified SMACNA leakage class requirements. The Contractor shall follow SMACNA procedures for testing as outlined in SMACNA's HVAC Air Duct Leakage Test Manual.

### **3.02 INDIVIDUAL SYSTEM TESTING**

- A. The Contractor shall assist the ATC contractor with individual system testing by operating the HVAC equipment. The Contractor shall coordinate with other trades as required to complete the testing activities with minimal disruption to the owner's staff and operation of the facility.
- B. All systems shall be tested to verify the system operates per the respective equipment specifications and Control Strategies. The testing shall systematically test all control functions including but not limited to all logic sequences, modes of operation, interlocks, alarms, safeties, adjustable setpoints, and instrument readings at all control panels.

### **3.03 REPAIR FOLLOWING TESTING PROCEDURES**

- A. All repair work shall be completed at no additional cost to the Owner.
- B. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings using materials identical to those removed.
- D. Seal ducts, test, and repair leaks created during the testing procedures on the air systems.
- E. Seal insulation to re-establish integrity of the vapor barrier at all locations where the vapor barrier was disturbed during the testing procedures.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with suitable permanent means of identification.



**END OF SECTION**

**SECTION 23 07 00**  
**HVAC INSULATION**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

**1.02 SUMMARY**

- A. Work Included:
  - 1. Flexible Elastomeric Duct Insulation
  - 2. Flexible Elastomeric Pipe Insulation
  - 3. Jacketing
  - 4. Accessories
  - 5. Duct Insulation Accessories
  - 6. Duct Insulation Compounds
  - 7. Outdoor Ducting Cover

**1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. Without limiting the generality of other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials”.
  - 2. ASTM C533 “Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation”.
  - 3. NFPA 255 “Standard Method of Test of Surface Burning Characteristics of Building Materials”.

4. ASTM C921 “Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation”.
5. ASTM C1071A “Standard Specification for Fibrous Glass Duct Lining Insulation”.
6. ASTM C1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”.

#### **1.04 SUBMITTALS**

- A. Shop Drawings: Submit for approval, Shop Drawings showing the following:
  1. Manufacturers' catalog literature, specifications, and illustrations with the following information:
    - a. Thermal properties.
    - b. Physical properties (thickness, density, etc.).
    - c. Fire hazard ratings.
    - d. Facing information.
    - e. Installation instructions.
    - f. Jointing recommendations for butt joints and longitudinal seam.
    - g. Fabrication instructions for duct fittings and valve insulation and coatings.
  2. Schedule of Project Specific Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated and for which type of duct or piping system it is associated with. Submit a tabular schedule for the entire project.
  3. Samples: For each type of insulation and field-applied jacket. Identify each Sample, describing product and intended use. Submit 8-inch square sections of each sample material.
  4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

#### **1.05 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training. Company or firm that

employs the insulation installers shall have a minimum of 5 years of experience in the business of installing HVAC related duct and piping insulation systems.

- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Supply insulation products that assure excellent IAQ (Indoor Air Quality) performance through Greenguard Certification whenever possible.
- E. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- F. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- G. Design Criteria: Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following fire hazard classifications:
  - 1. Flame spread, 25 maximum.
  - 2. Fuel contributed, 50 maximum.
  - 3. Smoke developed, 50 maximum.
- H. Source Quality Control: Perform the following tests and inspections at the factory:
  - 1. Flame spread.
  - 2. Smoke developed.
  - 3. Fuel contributed.
- I. Requirements of Regulatory Agencies:
  - 1. Permits: Contractor shall obtain and pay for all required fees, inspections and approvals by authorities having jurisdiction.
  - 2. Building Codes: Comply with applicable requirements of all State and local building codes.
  - 3. Underwriters' Laboratories, Incorporated.
  - 4. National Fire Protection Association.

- J. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified:
  - 1. Federal Specification HH 1 558B, Insulation Blocks, Boards, Blankets, Felts, Sleeves, Duct Fitting Covering.
  - 2. ASTM C 547, Mineral Fiber Preformed Duct Insulation.
  - 3. ASTM E 84, Surface Burning Characteristics of Building Materials.
- K. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

### **1.06 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Delivery of Material: Material shall be delivered to the job site in corrugated cartons.
- B. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- C. Storage of Material:
  - 1. Store material in clean, dry area, out of the weather.
  - 2. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
  - 3. Material shall remain in original cartons until time of installation.
  - 4. Insulation and Mold: Store all cartons of insulation elevated off the floor on pallets or wood blocking away from dust, dirt and debris. Store in a clean, dry, well-ventilated area. Carefully inspect any insulation that has been exposed to water. If insulation shows any sign of mold growth it must be discarded. If the material is wet but shows no sign of mold, it should be dried rapidly and thoroughly. If it shows signs of facing degradation from wetting, it should be replaced. Mineral fiber based air handling insulation used in the air stream must be discarded if exposed to water regardless of signs of mold.

### **1.07 JOB CONDITIONS**

- A. Protection:
  - 1. All material applied in one day shall have the vapor barrier applied the same day and any exposed ends shall be temporarily protected with a moisture barrier and sealed to the duct.

2. Insulating materials shall, at all times, be protected from moisture.
3. Material shall be warehoused on or near the job site and drawn from this protected area as used.

#### **1.08 DEFINITIONS**

- A. Greenguard: Greenguard Environmental Institute, independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOCs), including formaldehyde and other specific product-related pollutants. Provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.
- B. IAQ: Indoor Air Quality
- C. EPA: Environmental Protection Agency
- D. WHO: World Health Organization
- E. ASJ: All Service Jacket
- F. SSL: Self-Sealing Lap
- G. FSK: Foil-Scrim-Kraft; jacketing
- H. PSK: Poly-Scrim-Kraft; jacketing
- I. PVC: Polyvinyl Chloride
- J. FRP: Fiberglass Reinforced Plastic

#### **1.09 COORDINATION**

- A. Schedule insulation application after testing duct and piping systems. Insulation application may begin on segments of duct or piping that has satisfactory test results. Do not install insulation prior to building interior being fully enclosed and weather tight.
- B. Coordinate clearance requirements with duct and piping installers for insulation application.
- C. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "hangers and Supports for HVAC Piping."
- D. Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

#### A. Flexible Elastomeric Duct Insulation:

1. Armacell LLC Armaflex
2. K-Flex USA
3. Aeroflex USA
4. Or approved equivalent.

#### B. Flexible Elastomeric Pipe Insulation:

##### 1. Insulation:

- a. Armacell LLC Armaflex
- b. K-Flex
- c. Or approved equivalent.

##### 2. Glue:

- a. Armacell LLC Armaflex Low VOC Adhesive
- b. K-Flex
- c. Or approved equivalent.

##### 3. Paint:

- a. Armacell LLC Armaflex
- b. K-Flex
- c. Or approved equivalent.

#### C. Jacketing:

1. ITW Insulation Systems
2. Johns Manville
3. GLT Products

4. Or approved equivalent.

D. Accessories:

1. ITW Insulation Systems
2. Johns Manville
3. GLT Products
4. Or approved equivalent.

E. Duct Insulation Accessories:

1. Certainteed
2. Johns Manville
3. Owens-Corning
4. Or approved equivalent.

F. Duct Insulation Compounds:

1. Certainteed
2. Johns Manville
3. Owens-Corning
4. Or approved equivalent.

## **2.02 FLEXIBLE ELASTOMERIC DUCT INSULATION**

A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. Thermal Conductivity Value: 0.28 BTU\*in/(hr\*sf°F) at 75 degrees F.
2. Maximum Service Temperature of 220 degrees F.
3. Maximum Flame Spread: 25.
4. Maximum Smoke Developed: 50 (1-inch thick and below).
5. Connection: Waterproof vapor retarder adhesive as needed.
6. UV Protection: UV outdoor protective coating as needed per manufacturer's requirements.



- B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam.
- C. Paint: Nonhardening high elasticity type, manufactured as protective covering of flexible elastomeric foam insulation for prevention of degradation due to exposure to sunlight and weather.

### **2.03 FLEXIBLE ELASTOMERIC PIPE INSULATION**

- A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
  - 1. Thermal Conductivity Value: As indicated in the insulation tables below.
  - 2. Maximum Service Temperature of 220 degrees F.
  - 3. Maximum Flame Spread: 25.
  - 4. Maximum Smoke Developed: 50 (1-inch thick and below).
  - 5. Connection: Waterproof vapor retarder adhesive as needed.
  - 6. UV Protection: UV outdoor protective coating per manufacturer's requirements.
- B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam.
- C. Paint: Nonhardening high elasticity type, specifically manufactured as protective covering of flexible elastomeric foam insulation for prevention of degradation due to exposure to sunlight and weather.

### **2.04 JACKETING**

- A. Canvas Jacket: UL listed fabric, 6 ounce/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.
- B. PVC preformed molded insulation covers. Zeston or approved equivalent.
- C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.
- D. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish.

### **2.05 ACCESSORIES**

- A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

- B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
- C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide non-water soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

## **2.06 DUCT INSULATION ACCESSORIES**

- A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

## **2.07 DUCT INSULATION COMPOUNDS**

- A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

# **PART 3 – EXECUTION**

## **3.01 GENERAL INSTALLATION REQUIREMENTS**

- A. Verification of Conditions:
  - 1. Do not apply insulation until pressure testing and inspection of ducts and piping has been completed.
  - 2. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Preparation: Clean and dry surfaces to be insulated.
- C. Installation:
  - 1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
  - 2. Piping and Equipment:

- a. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
  - b. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.
- D. Provide accessories as required. See Part 2 Article "Accessories" above.
- E. Protection and Replacement: Installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- F. Labeling and Marking: Provide labels, arrows and color on piping and ductwork. Attach labels and flow direction arrows to the jacketing per Section 23 05 53 – Identification for HVAC Piping, Ductwork and Equipment.
- G. Ductwork:
- 1. Install insulation in conformance with manufacturer's recommendations to completely cover duct.
  - 2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
  - 3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form complete unbroken vapor seal over insulation.
  - 4. Coat staples and seals with vapor barrier coating.
  - 5. Cover breaks in jacket materials with patches of same material as vapor barrier. Extend patches not less than 2-inches beyond break or penetration on all directions and secure with adhesive and staples. Seal staples and joints with vapor barrier coating.
  - 6. Fill jacket penetrations. i.e., hangers, thermometers and damper operating rods, and other voids in insulation with vapor barrier coating. Seal penetration with vapor barrier coating. Insulate hangers and supports for cold duct in un-conditioned spaces to extent to prevent condensation on surfaces.

7. Seal and flash insulation terminations and pin punctures with reinforced vapor barrier coating.
  8. Continue insulation at fire dampers and fire/smoke dampers up to and including those portions of damper frame visible at outside of the rated fire barrier. Insulating terminations at fire dampers in accordance with this Section.
  9. Do not conceal duct access doors with insulation. Install insulation terminations at access door in accordance with this Section.
- H. Insulated Pipe Exposed to Weather: Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints.
- I. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, non-compressible insulation section at insulation shields for lines 2-inches and larger (hot and cold) piping.
- J. Ductwork Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Duct Size	Insulation Thickness
Supply ductwork where duct is not specified to be lined.	Flexible Elastomeric	All	1.5-inch
Return ductwork where duct is not specified to be lined.	Flexible Elastomeric	All	None
Supply ductwork (exposed to weather, in crawl space and in unheated attics)	Flexible Elastomeric	All	3-inch
Return ductwork (exposed to weather, in crawl space and in unheated attics)	Flexible Elastomeric	All	3-inch
Outside Air Ducts	Flexible Elastomeric	All	3-inch
Exhaust ducts within 10-feet of exterior	Flexible Elastomeric	All	3-inch
Exposed insulation in mechanical rooms or areas subject to damage	Flexible Elastomeric	All	1.5-inch
Supply ductwork exposed in process areas	Uninsulated	All	NA
Exhaust ductwork exposed in process areas	Uninsulated	All	NA

Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

**3.02 FLEXIBLE ELASTOMERIC DUCT INSULATION**

- A. Install insulation in conformance with manufacturer's recommendations and requirements.

**3.03 FLEXIBLE ELASTOMERIC PIPE INSULATION**

- A. Flexible Elastomeric Insulation:
  - 1. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and below grade with two coats of finish as recommended by manufacturer.
- B. Flexible Elastomeric Tubing:
  - 1. Flexible Elastomeric Tubing: Slip insulation over piping or, if piping is already installed, slit insulation and snap over piping. Joints and butt ends must be adhered with 520 adhesive.
- C. See General Installation Requirements above.
- D. Install insulation in conformance with manufacturer's recommendations and requirements.
- E. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.
- F. Install in accordance with manufacturer's instructions for below grade installation.
- G. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Conductivity Range (Btu- inch per hour per SF per degrees F)	Pipe Size (Inches)	Insulation Thickness (Inches)
Refrigerant Suction Piping (40F to 60F)	Flexible Elastomeric	0.21-0.27 at a mean rating temperature of 75 degrees F	<1	0.75
			1 to <1.5	0.75
			1.5 to <4	1.0
			4 to <8	1.0
			>= 8	1.0

Item to be Insulated	System Insulation Type	Conductivity Range (Btu- inch per hour per SF per degrees F)	Pipe Size (Inches)	Insulation Thickness (Inches)
Refrigerant Suction Piping (<=40F)	Flexible Elastomeric	0.20-0.26 at a mean rating temperature of 50 degrees F	<1	1.0
			1 to <1.5	1.5
			1.5 to <4	1.5
			4 to <8	1.5
			>= 8	1.5

Note: Insulation thickness shown is a minimum. If state code requires additional thickness, then provide insulation thickness per code requirements.

### 3.04 JACKETING

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturer's instructions.

### 3.05 ACCESSORIES

- A. Install insulation in conformance with manufacturer's instructions, recommendations and requirements.
- B. See General Installation Requirements above.
- C. Provide and install accessories for all insulation types listed in this Section.

### 3.06 DUCT INSULATION ACCESSORIES

- A. Install insulation in conformance with manufacturer's recommendations and requirements.

### 3.07 DUCT INSULATION COMPOUNDS

- A. Install insulation in conformance with manufacturer's recommendations and requirements.

**END OF SECTION**

**SECTION 23 08 00**  
**COMMISSIONING OF HVAC SYSTEMS**

**PART 1 – GENERAL**

**1.01 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 75 00 – Checkout and Startup Procedures. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 75 00 – Checkout and Startup Procedures. A Commissioning Agent (CxA) appointed by the Owner will manage the commissioning process.

**1.02 RELATED WORK**

- A. Section 00 72 00 – General Conditions
- B. Section 01 75 00 – Checkout and Startup Procedures
- C. Section 01 33 00 – Submittal Procedures

**1.03 SUMMARY**

- A. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 75 00 – Checkout and Startup Procedures.
- B. Refer to Section 01 75 00 – Checkout and Startup Procedures for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.04 DEFINITIONS**

- A. Refer to Section 01 75 00 – Checkout and Startup Procedures for definitions.

**1.05 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's Operation and Maintenance personnel in accordance with the requirements of Section 01 75 00 – Checkout and Startup Procedures and of Division 23, is required in cooperation with the Owner and the Commissioning Agent.

- B. The Facility exterior closure systems commissioning will include the systems listed in Section 01 75 00 – Checkout and Startup Procedures.

### **1.06 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Owner prior to forwarding to the Contractor. Refer to Section 01 33 00 – Submittal Procedures for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 75 00 – Checkout and Startup Procedures.

### **1.07 HEATING, VENTILATING, BUILDING AUTOMATION SYSTEMS (BAS), AND TAB WORK**

- A. The commissioning tasks applicable to the mechanical, BAS and TAB work of Division 23 are as follows (all references apply to equipment to be commissioned only):
  - 1. Construction and Acceptance Phase Requirements
    - a. Submittal data, commissioning documentation, O&M data and training.
    - b. Attend all commissioning meetings.
    - c. Provide shop drawings of equipment to be commissioned along with completed & signed Pre-Functional checklists.
    - d. Document start-up and functional testing procedures including.
      - 1) Manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, Owner-contracted tests, fan and pump curves, all factory testing reports, and all warranty information.
    - e. Table of Contents with listing of all equipment that will be included in the O&M manuals for review and approval.
    - f. Specific functional performance test procedures.
    - g. Alarm limits to be used during the tests.
    - h. Start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists for all equipment to be commissioned. Submit to Owner's Representative for review and approval prior to startup.



Refer to Section 01 75 00 – Checkout and Startup Procedures for further details on start-up plan.

- i. Prior to startup and initial checkout process, execute the mechanical prefunctional checklists for all equipment to be commissioned.
- j. Perform and clearly document all system operational checkout procedures and completed startup, promptly providing a copy to the Owner as components are completed and systems are debugged and completed.
- k. Correct all punch list items before functional testing.
- l. Air and water TAB shall be completed with discrepancies and problems remedied before requesting Owner witnessing functional testing.
- m. Functional Performance Tests / Procedures may be used to perform adjustments prior to witnessing by the Owner's Representative and Owner.
- n. Complete functional performance testing for specified equipment in Section 01 75 00 – Checkout and Startup Procedures.

B. Assist the Owner in interpreting the monitoring data.

- 1. Correct deficiencies as interpreted by the Contract Manager/General Contractor and Owner's Representative and retest the equipment prior to Functional Performance Witnessing by the CxA. Coordinate scheduling of Functional Performance Witnessing with the Contract Manager/General Contractor and Owner.
- 2. Provide all Documentation, Plans, Reports, Notes, Output from Electronic Commissioning Tools / other analysis tools to the Owner promptly upon successful Functional Test witnessing.
- 3. Update O&M manuals according to the Contract Documents.
- 4. Provide training of the Owner's operating staff.
- 5. Document specific requirements to maintain the validity of the warranty.

### **1.08 WARRANTY PERIOD**

- A. Execute seasonal or deferred functional performance testing, witnessed by the Owner.
- B. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

**PART 2 – PRODUCTS (NOT USED)****PART 3 – EXECUTION****3.01 GENERAL REQUIREMENTS**

- A. This Section establishes general requirements pertaining to HVAC commissioning of building systems, equipment and appurtenances.
- B. Commissioning is intended to achieve the following specific objectives of the Contract Documents.
  - 1. Verify and document proper installation and design parameters of equipment, systems, and integrated systems.
  - 2. Ensure that operating and maintenance and Commissioning documentation requirements are complete.
  - 3. Provide Owner with functional buildings and systems that meet the Contract Document and Owner's operational requirements at Substantial Completion.
- C. The Contractor shall deliver a successful Commissioning process. It is of primary concern that all operable systems installed in the Project perform in accordance with the Contract Documents and the specified Owner's operational requirements. During Commissioning, the Contractor shall systematically demonstrate to the Owner that the operable systems are properly performing in strict accordance with the Contract Documents and Owner requirements.
  - 1. Commissioning requires cooperation and involvement of all parties throughout the construction process.
  - 2. Successful Commissioning requires that installation of all building systems complies with Contract Document requirements and that full operational check-out and necessary adjustments are performed prior to Substantial Completion, with the exception of deferred tests approved in advance by the Owner's Representative.
  - 3. Commissioning will encompass and coordinate traditionally separate functions of: system documentation, Inspection, Pre-functional Checklists and start-up, control system calibration and point-to-point checkout, Testing, Adjusting, and Balancing, Functional Performance Tests, Integrated System Tests, Contractor demonstration to the Owner, and Training of Owner's personnel. This requires assembling all related documentation into one Commissioning Manual.

4. Interim Reports and Final Commissioning Manual shall be submitted in electronic, fully searchable, portable document format, for review and approval by the Owner's Representative and the Owner.
  5. Design Review by Cx Provider: Prior to the Construction-phase, the Cx-Provider shall perform a design review at 50% and 95% CD stages of project. They examine the contract documents and comment on design concepts, suitability for the project, adherence to the OPR, Owner's standards and specifications, O&M requirements and industry best practices.
- D. Certify that HVAC systems, BAS, subsystems, and equipment have been installed, calibrated, and started and operating according to the Contract Documents, manufacturer's specifications, Owner's standards and specifications, and approved Shop Drawings and submittals.
  - E. Certify that HVAC instrumentation and control systems have been installed and calibrated, that they are operating according to the Contract Documents, Owner's standards and specifications, and approved Shop Drawings and submittals, and that pretest set points have been recorded.
  - F. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
  - G. Set systems, subsystems, and equipment into operating modes to be tested according to approved test procedures. Modes required to be tested include normal start-up, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.
  - H. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
  - I. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.
  - J. Construction Checklists: Prepare and submit detailed construction checklists for HVAC systems, subsystems, equipment, and components.
  - K. Perform tests using design conditions, whenever possible.
    1. Simulated conditions may, with approval of Owner's Representative, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Owner's Representative and

- document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
  3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- L. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
- M. Include seasonal testing. Complete appropriate initial performance tests and documentation and schedule seasonal tests.
- N. Coordinate schedule with and perform the following activities at the direction of Owner's Representative.
- O. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.
- P. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
1. Performance tests.
  2. Demonstration of a sample of performance tests.
  3. Commissioning tests.
  4. Commissioning test demonstrations.
- Q. Construction Meetings: The Cx Agent conducts regular meetings during construction to identify and assist in resolving issues, including, but not limited to, submittal reviews, BAS sequences, construction quality deficiencies, Owner's standards adherence, receipt of as-built drawings and schedule concerns.
1. Commissioning Construction List tracking – shall include a list of items to be resolved, date identified, required action, responsible party and date resolved.
  2. Tracking shall be via e-Builder.

- R. Final Cx Report. The Cx Agent provides a Final report within 6 months of building occupancy, with a Final Addendum issued within 10-days of 10-month Warranty Review. Report shall include:
1. Executive Summary.
  2. Construction List
  3. Commissioning checklists.
  4. BAS as-built drawings.
  5. Operations Manual.
  6. TAB report.
- S. Quality Assurance. Commissioning procedures shall be in accordance with NEBB, ASHRAE, AEE or BCxA. Commissioning agent is certified by one of these groups.

### **3.02 CONSTRUCTION INSPECTIONS**

- A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 75 00 – Checkout and Startup Procedures and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

### **3.03 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the Owner and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 75 00 – Checkout and Startup Procedures for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

**3.04 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 00 72 00 – General Conditions. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

**3.05 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:**

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 75 00 – Checkout and Startup Procedures and Section 01 75 00 – Checkout and Startup Procedures, for additional details.

**3.06 TRAINING OF OWNER'S PERSONNEL**

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 75 00 – Checkout and Startup Procedures. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 75 00 – Checkout and Startup Procedures and Division 23 Sections for additional Contractor training requirements.

**END OF SECTION**

**SECTION 23 09 00**  
**HVAC AUTOMATIC TEMPERATURE CONTROLS**

**PART 1 – GENERAL****1.01 REQUIREMENTS**

- A. The SCADA CONTRACTOR shall furnish and install all HVAC Automatic Temperature Controls (ATC) components and accessories in accordance with the Division 40 Specifications.
- B. HVAC Automatic Temperature Controls (ATC) shown on the HVAC drawings and drawings I004 through I006 shall comply with the scope described in this specification as well as with system controls as specified in Division 40. All HVAC Control systems shall be furnished and installed by the SCADA Contractor and fully integrated with the SCADA system
- C. HVAC equipment and controls shall be furnished and installed to operate as a system. The SCADA CONTRACTOR shall coordinate all requirements between Manufacturers to insure unit responsibility and compatibility of the equipment and controls.
- D. All labor, material, equipment and software not specifically referred to herein or on the plans, which are required to meet the functional intent of this specification, including the integration to existing applications and reporting, shall be provided without additional cost to the OWNER.
- E. ATC control systems indicated on the Drawings or Specifications and control devices such as thermostats, etc., indicated to be 24 volts or less shall be supplied, mounted, wired, and terminated by the SCADA CONTRACTOR. The SCADA CONTRACTOR shall size and provide low voltage transformers where required.
- F. Wiring and Conduit:
  - 1. All 480V 3-phase wiring and conduit as well as all 120V power supply wiring and conduit to HVAC control panels shall be provided under Division 26 – Electrical by the ELECTRICAL CONTRACTOR.
  - 2. 120V and 24V control wiring and conduits between HVAC Control Panels and other HVAC control panels, field devices, instruments, and dampers shall be installed and terminated by the SCADA CONTRACTOR.
  - 3. Conduit and wires between HVAC control panels and non-HVAC equipment and control panels (SCADA, FACP, etc.) shall be provided under Division 26 - Electrical and provided by the ELECTRICAL CONTRACTOR. Wire terminations in HVAC Control panels shall be by the SCADA CONTRACTOR and terminations for

non-HVAC control panels shall be provided by the ELECTRICAL CONTRACTOR. Wiring and terminations shall meet all the requirements of Division 26.

- G. The SCADA system shall be capable of being expanded in future phases of upgrades on existing controls and equipment for total integration of the facility infrastructure HVAC systems. Web access of the SCADA system is prohibited.

## 1.02 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
1. The SCADA CONTRACTOR shall submit shop drawings on all equipment, accessories, and appurtenances and all fabrication work or other mechanical and air conditioning work required.
  2. Include all specification technical exceptions in the submittal. The manufacturer agrees that the equipment is compliance with Specification Sections that are not identified in the list of technical exceptions.
  3. Submit documentation in the following phased delivery schedule:
    - a. Control equipment hardware and software.
    - b. System schematics, including:
      - 1) Sequence of operation
      - 2) Point names
      - 3) Point addresses
      - 4) Point to point wiring
      - 5) Interface wiring diagrams
      - 6) Panel layouts
      - 7) System Diagrams
      - 8) Logic Diagrams
      - 9) GUI Screen graphics, menus, and layouts
  4. All instruction books and manuals.
  5. Closeout Submittals: Submit warranty documentation.



6. The SCADA CONTRACTOR shall submit heat generation calculations for each panel. The calculations shall take into account the panel construction and equipment installed within and shall show if natural heat transfer through the panel walls is sufficient or if supplemental cooling is required.
  - a. Ambient conditions for indoor panels in air-conditioned spaces shall assume 85°F unless otherwise noted.
  - b. Ambient conditions for indoor panels in un-air-conditioned areas shall assume 104°F unless otherwise noted.
  - c. Ambient conditions for outdoor panels shall assume 120°F unless otherwise noted.
7. Upon completion of the work, provide a complete set of 'as-built' control drawings in AutoCAD 2017 or newer file format.
8. The SCADA CONTRACTOR shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in General Conditions and Division 01. Operation and Maintenance Manuals shall be submitted for all equipment as follows:
  - a. Index sheet, listing contents in alphabetical order.
  - b. Manufacturer's equipment parts list of all functional components of the system, disk of system schematics, including wiring diagrams.
  - c. Description of sequence of operations.
  - d. As-Built interconnection wiring diagrams.
  - e. User's documentation containing product, system architectural and programming information.
  - f. Trunk cable schematic showing remote electronic panel locations, and all trunk data.
  - g. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.).
  - h. Conduit routing diagrams.
  - i. Copy of the warranty.
  - j. Operating and maintenance manuals and instructions.
  - k. Recommended spare parts list.

**1.03 DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store, protect and handle products to the Project Site under the provisions of the Contract Documents.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

**1.04 SCADA MANUFACTURER'S INSTRUCTIONS**

- A. Installation of all equipment shall be in accordance with Manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all Manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the OWNER, and the use of other trades.
- E. Turn over all data to the OWNER at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 01.

**1.05 SOFTWARE LICENSE AGREEMENT**

- A. The OWNER shall sign a copy of the Manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the OWNER as defined by the Manufacturer's license agreement including but not limited to:
  - 1. Graphic
  - 2. Record Drawings
  - 3. Database
  - 4. Application programming code
  - 5. Documentation

## 1.06 SCHEDULES ON DRAWINGS

- A. In general, all capacities of equipment and characteristics are as indicated in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities indicated are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the ENGINEER.

## 1.07 CODE, PERMIT AND STANDARDS

- A. Resolve any code violation discovered in contract documents with the OWNER prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to the OWNER.
- B. The SCADA CONTRACTOR shall obtain all permits and shall comply with all laws and codes that apply to the Work. The Owner shall pay all permit fees.
- C. The SCADA CONTRACTOR shall be responsible for all added expenses due to their choice of equipment, materials, or construction methods.
- D. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Mechanical Code, and all local codes. Nothing in the Drawings and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- E. Referenced Standards:
  - 1. ASTM International (ASTM)
    - a. D1693 – Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
  - 2. Instrumentation – Systems, and Automation Society (ISA)
    - a. S5.1 – Instrumentation Symbols and Identification
    - b. S5.4 – Standard Instrument Loop Diagrams
  - 3. National Electrical Manufacturers Association (NEMA)
    - a. 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
  - 4. National Fire Protection Association (NFPA)
    - a. 70 – National Electrical Code (NEC)
  - 5. Underwriters Laboratories, Inc. (UL)

## 1.08 QUALITY ASSURANCE

- A. Installer Qualifications (the SCADA CONTRACTOR): All work described in this Section shall be installed, wired, circuit tested and calibrated by the SCADA CONTRACTOR'S factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the Manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the Manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).
- B. Manufacturer Qualifications (ATC Manufacturer): Company specializing in manufacturing the products specified in this Section with a minimum of five (5) years documented experience, who issues complete catalog data on total product.
- C. All material and equipment shall be of the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- D. When two or more units of the same class of material or equipment are required, they shall be products of a single Manufacturer.
- E. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the Manufacturers and in accordance with specified codes and standards.
- F. Touch up and/or repaint to match original finishes for factory finished or painted equipment and materials which are scratched or marred during shipment or installation shall be performed as follows:
  - 1. Immediately after installation, sand smooth any rusted or damaged areas of shop paint and primer.
    - a. Furnish air-drying touch-up paint and compatible air-drying primer to be applied by the CONTRACTOR.

## 1.09 ACRONYMS USED IN THIS SPECIFICATION

- A. ATC – Automatic Temperature Control
- B. DDC – Direct Digital Control
- C. FACP – Fire Alarm Control Panel
- D. GUI – Graphical User Interface

- E. HMCP – HVAC Master Control Panel
- F. IDC – Interoperable Digital Controller
- G. LCP – Local Control Panel
- H. LAN – Local Area Network
- I. NAC – Network Area Controller
- J. ODBC – Open Database Connectivity
- K. WAB – Web Browser Interface
- L. WAN – Wide Area Network

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Provide a control system as defined by Section 40 61 13 Process Control Systems and related sections.

### **2.02 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES**

- A. The intent of this Section is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate the SCADA communication protocols in one open, interoperable system. Provide in accordance with Division 40 requirements.
- B. All controllers supplied under this contract shall be true “peer-to-peer” communicating devices.
- C. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant database is required for all system database parameter storage. Systems requiring the OWNER to purchase a separate copy of proprietary database and user interface programs shall not be acceptable.

### **2.03 FIELD DEVICES**

- A. Provide automatic control valves, automatic control dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Except as otherwise indicated, provide Manufacturer’s standard control system components as indicated by published product information, designed and constructed as recommended by Manufacturer.

## B. Electronic Actuators

1. Operating Temperature range shall be from -20 to 200°F (-29 to 90°C).
2. The actuator shall be provided with open and close limit switches. The open limit switch shall be adjustable.
3. Provide damper position indicator. The indicator is not required to be visible on the exterior of NEMA 4X and NEMA 7 actuator enclosures.
4. Size each actuator to operate dampers with sufficient reserve power to provide smooth modulating action or 2-position action as specified.
5. Actuators shall be direct coupled type.
6. All actuators shall fail closed by an integrated spring return system unless specifically indicated otherwise by the Drawings. The actuator shall be capable of providing clockwise or counterclockwise fail safe operation based on the required mounting.
7. Actuators shall be protected from overload at all angles of rotation.
8. Actuators shall be UL approved.
9. The actuators shall be constructed to meet the requirements for double insulation so an electrical ground is not required to meet agency listings.
10. All dampers shall receive power from the respective HVAC ventilation control panel that they serve.
11. Actuator NEMA rating shall match the rating indicated on the Control Flow Diagrams for the space in which it is located. Where actuators are not available in the designated NEMA rating, enclosures shall be provided by the damper actuator to achieve the required NEMA rating.

## C. Thermostats

1. Thermostats shall have a means to adjust the space temperature setpoint on the thermostat.
2. Thermostat shall have a display capable of showing the current space temperature, space temperature setpoint, schedule, heating/cooling mode, and the current time.

## D. Air Differential Pressure Sensor

1. Sensors shall have field selectable ranges.

2. Sensor shall be loop powered.
3. Sensor shall have local readout of the current differential pressure.
4. Sensor shall be capable of outputting a 4-20 mA reading of the differential pressure.
5. NEMA rating of the sensor shall be suitable for the NEMA rating of the space as indicated on the Control Flow Diagrams.
6. Pressure sensing line shall be 316 stainless steel 3/8" tubing. Exterior sensing lines shall be protected from wind with a capped with a removable screen fitting.

E. Duct Smoke Detectors

1. Provide smoke detectors in accordance with NFPA 90A and as indicated on the Drawings. Provide UL listed or FM approved detectors for duct installation.
2. Provide duct detectors with an approved duct housing, mounted exterior to the duct, and with perforated sampling tubes extending across the width of the middle of the duct. All detectors shall be furnished with remote key operated test stations
3. Provide an access door in the ductwork for inspection and maintenance.
4. Duct smoke detectors for classified locations shall be the air aspiration addressable type designed for remote sensor location for ducts with difficult service access. The detector and housing shall be located on the wall of an adjacent unclassified space as indicated on the design drawings. Sample tubes shall be installed in rigid aluminum conduit for protection.
5. Duct smoke detectors for unclassified locations shall be installed on the ductwork as indicated in the design drawings. Detectors shall be addressable type in NEMA 4 enclosure.
6. All duct smoke detectors shall have a following
  - a. The detectors shall operate at air velocities from 300 to 4,000 feet per minute.
  - b. Visual indication of alarm must be provided on the detector front and mounted at a 30-degree slant to provide a wide viewing angle. A manual reset/test switch shall be located on the front of the device. A remote reset/test function shall be provided for all smoke detectors.
  - c. Detector heads shall not require additional filters or screens which must be maintained. The housing shall contain a detector base which shall accept photoelectric or ionization heads. Terminal connections shall be provided for

remote alarm indication and remote reset/test switches. All wiring must comply with local codes and regulations.

- d. Duct detectors located higher than 6 feet above the floor shall be provided with remote keyed test stations.
7. Duct detectors for classified spaces shall be Gamewell – FASST series or approved equal. Duct detectors for unclassified spaces shall be Gamewell – DNRW series or equal.

## **2.04 TOOLS, SUPPLIES, AND SPARE PARTS**

- A. Furnish all special tools, supplies and spare parts necessary to install, disassemble, service, and repair the equipment.
- B. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number. Spare parts shall be packed in individual, suitable containers clearly labeled with the part number; name, quantity, and the equipment for which they are intended.
- D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The CONTRACTOR shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the OWNER.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Install system and materials in accordance with Manufacturer's instructions, and as detailed on the Drawings.
- B. All communication wiring shall be separate from any wiring above 30 volts.
- C. All wiring shall be labeled with BRADY style wire markers at each end.
- D. Provide signal conditioning devices and surge protection devices for Controllers, Control Panels and peripherals.
- E. Drawings of temperature control systems are diagrammatic only and any apparatus not indicated, such as relays, accessories, etc., but required to make the system operative



to the complete satisfaction of the OWNER shall be furnished and installed at no additional cost to the OWNER.

### 3.02 SYSTEM CONFIGURATION

- A. The system shall comply with Division 40 requirements.

### 3.03 SEQUENCE OF OPERATION

- A. The SCADA Control Panel shall control the process as well as heating and ventilation in the Dewatering Building. The make-up air unit, MAU-DW-001, Supply fans SF-DW-001, SF-DW-002, SF-DW-003 and exhaust fans, EF-DW-001, EF-DW-002, EF-DW-003, EF-DW-004, EF-DW-005, EF-DW-006, EF-DW-007, EF-DW-008, EF-DW-009 and EF-DW-010 and control damper, MD-DW-001, MD-DW-002, MD-DW-003, MD-DW-004, MD-DW-005, MD-DW-006, MD-DW-007, MD-DW-008, and MD-DW-010 shall be controlled by the SCADA system.
- B. Make-up Air Unit (DWB\_MAU-001):
1. Run Conditions - Scheduled:
    - a. The unit shall run continuously in the following modes:
      - 1) Occupied Mode: The unit shall maintain
        - a) A 85°F (adj.) cooling setpoint
        - b) A 65°F (adj.) heating setpoint.
      - 2) Unoccupied Mode: The unit shall maintain
        - a) A 90°F (adj.) cooling setpoint.
        - b) A 50°F (adj.) heating setpoint.
    - b. In addition to Occupied or Unoccupied the unit shall have a summer, normal and winter mode.
      - 1) Summer mode (Outside Air Temperature above 75 degrees F) shall be at the highest fan speed to produce nine (9) air changes per hour per table on the contract documents and EF-DW-001 and EF-DW-005 shall be energized. Motorized Control Damper, MD-DW-010, shall be open and shall modulate to achieve the air flow conditions per table on the contract documents. The number of presses in operation and which press is functioning will determine the final number of fans in operation.

- 2) Normal mode shall be at normal speed to produce six (6) air changes per hour per the table on the contract documents and EF-DW-001 and EF-DW-005 shall be deenergized. Motorized Control Damper, MD-DW-010, shall be open and shall modulate to achieve the air flow conditions per table on the contract documents. The number of presses in operation and which press is functioning will determine the final number of fans in operation.
  - 3) Winter mode (Outside Air Temperature below 50 degrees F and unoccupied) shall be at the lower speed to produce three (3) air changes per hour per the table on the contract documents and EF-DW-001 and EF-DW-005 shall be deenergized. Motorized Control damper, MD-DW-010 shall close. The number of presses in operation and which press is functioning will determine the final number of fans in operation.
2. Alarms shall be provided as follows:
- a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
  - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
3. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the SCADA HMI/OIT.
4. Freeze Protection: The unit shall generate an alarm upon receiving a freezestat (TSL H0643) status.
5. Smoke Detection: The unit shall shut down and generate an alarm upon receiving a smoke detector status.
6. Outside Air Damper: The outside air damper (MD-DW-001) shall open anytime the unit runs and shall close anytime the unit stops. The supply fans shall start only after the damper status has proven the damper is open. The outside air damper (MD-DW-001) shall close 4sec (adj.) after the supply fan stops.
- a. Alarms shall be provided as follows:
    - 1) Outside Air Damper Failure: Commanded open, but the status is closed.
    - 2) Outside Air Damper in Hand: Commanded closed, but the status is open.

7. Isolation dampers: The isolation dampers (MD-DW-004 and MD-DW-007) shall open anytime the unit runs and shall close anytime the unit stops. The supply fans shall start only after the damper status has proven the damper is open. The isolation air dampers (MD-DW-004 and MD-DW-007) shall close 4sec (adj.) after the supply fan stops.
8. Heat Recovery – Heat exchanger:
  - a. The controller shall open the dampers and allow air to pass thru the heat exchanger for energy recovery as follows.
  - b. Heating Recovery Mode:
    - 1) Heat recovery mode shall be active whenever the outdoor air temperature drops below 65° F.
    - 2) Upon entering heat recovery mode, the bypass dampers (MD-DW-003 and MD-DW-006) shall be closed and the heat exchanger face dampers (MD-DW-002 and MD-DW-005) shall be opened.
    - 3) The heat exchanger shall be utilized for heat recovery whenever:
      - a) Exhaust air from the Press Room temperature is 5°F (adj.) or more above the outside air temperature.
      - b) AND the zone temperature is below heating setpoint.
      - c) AND the supply fan is on.
    - 4) Heat recovery mode shall be deactivated whenever the outdoor temperature rises above 65° F. (adjustable).
    - 5) Upon exiting heat recovery mode, the bypass dampers (MD-DW-003 and MD-DW-006) shall open and the heat exchanger face dampers (MD-DW-002 and MD-DW-005) shall close.
9. Make-up Air Unit Supply Fans: The supply fans (SF-DW-001 and SF-DW-002) shall run anytime the unit is commanded to run. The supply fans shall modulate based upon the occupancy mode determined by the lighting contactor unless shutdown on safeties. The supply fans shall have a 600 sec (adj.) delay on stop in order to dry out the direct evaporative media.
  - a. Occupied Mode – Normal: The fans shall operate various speeds based upon the number of presses in operation to provide nominal airflow.
  - b. Occupied Mode – Summer: The fans shall operate at maximum speed when the space temperature exceeds the temperature set point.

- c. Unoccupied Mode – Winter: The fans shall operate at the minimum speed when the space is unoccupied as determined by the lighting contactor and the outdoor air temperature is below 50° F and the Combustible Gas Detection is within acceptable limits.
  - d. Alarms shall be provided as follows:
    - 1) Supply Fan Failure: Commanded on, but the status is off.
    - 2) Supply Fan in Hand: Commanded off, but the status is on.
    - 3) Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
    - 4) Supply Fan Airflow Failure
10. Make-up Air Unit Exhaust Fans: The exhaust fans (EF-DW-006, EF-DW-007 and EF-DW-008) shall run anytime the unit is commanded to run. The exhaust fans shall modulate based upon the occupancy mode determined by the lighting contactor unless shutdown on safeties.
- a. Occupied Mode – Normal: The fans shall vary speed to provide nominal airflow based upon the number of presses in operation..
  - b. Occupied Mode – Summer: The fan shall operate at maximum speed when the space temperature exceeds the temperature set point.
  - c. Unoccupied Mode – Winter: The fan shall operate at the minimum speed when the space is unoccupied as determined by the lighting contactor and the outdoor air temperature is below 50° F.
  - d. Alarms shall be provided as follows:
    - 1) Exhaust Fan Failure: Commanded on, but the status is off.
    - 2) Exhaust Fan in Hand: Commanded off, but the status is on.
    - 3) Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
    - 4) Exhaust Fan Airflow Failure.
11. Direct Evaporative Cooling Section: The Direct Evaporative Cooler controller shall measure the zone temperature and stage on the spray pump on rising temperature to maintain its cooling setpoint. The supply fan shall run for a user definable time (adj.) after the spray pump is disabled on unit shutdown in order to dry out the evaporative media.

- a. The evaporative cooling section shall be enabled whenever:
    - 1) Outside air temperature is greater than 80°F (adj.).
    - 2) AND outside air wetbulb is less than 63°F (adj.).
    - 3) AND the zone temperature is above cooling setpoint.
    - 4) AND the zone humidity is less than 60% rh (adj.)
    - 5) AND the supply fan status is on.
  - b. On rising zone temperature, the spray pump shall stage on.
  - c. When the space temperature drops below the cooling set point, the spray pump shall deenergize.
  - d. Sump Control: The controller shall drain and fill the sump as follows:
    - 1) Freeze Protection: If the outside air temperature drops below 40°F (adj), the evaporative cooler sump shall open the drain valve and close the fill valve. If the outside air temperature returns above 55°F (adj.), the controller shall activate the fill valve and close the drain valve.
    - 2) Scheduled Flush and Fill: A flush cycle shall occur every 48hr (adj.) at a user definable time (adj.) of day. At this time, the spray pump shall stop, the fill valve shall close, and the drain valve shall open for 600 sec (adj.). After the cycle time is complete, the drain valve shall close, the fill valve shall open, and the spray pump shall be enabled.
  - e. Alarms shall be provided as follows:
    - 1) Spray Pump Failure: Commanded on, but the status is off.
    - 2) Spray Pump in Hand: Commanded off, but the status is on.
    - 3) Spray Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
12. Gas Heating Stages: The controller shall measure the zone temperature and stage the heating to maintain its heating set point. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
- a. The heating shall be enabled whenever:

- 1) Outside air temperature is less than 65°F (adj.).
  - 2) AND the zone temperature is below heating setpoint.
  - 3) AND the fan status is on.
- b. Upon a call for heating the burner control module shall:
- 1) Energize the draft inducer blower and operation will be verified by the pressure switch in the exhaust flue.
  - 2) After 30 seconds (adj.) the ignitor will be energized.
  - 3) The controller shall open the first stage gas valve to allow fuel flow.
  - 4) The flame sensor will sense ignition and turn the ignition source off. If the burners do not ignite within 5 to 6 seconds and the flame sensor does not sense a flame the burner control shall deenergize the gas valve.
  - 5) After 5 minutes if the space temperature sensor has not reached the intended set point, the burner control module will energize the second stage of heating. The third stage shall be energized after an additional 5 minutes if the set point is not met.
  - 6) The burner control module shall modulate the stages of heat to maintain the desired space set point temperature.
  - 7) Once the desired set point has been exceeded at the temperature sensor the burner controller shall deenergize the heating and close the gas valves.
  - 8) The draft inducer shall continue to run for 60 seconds after the gas valves are closed to purge the burner heat exchanger.
13. Filter Differential Pressure Monitor: The controller shall monitor the differential pressure across the filter.
- a. Alarms shall be provided as follows:
    - 1) Filter Change Required: Filter differential pressure exceeds a user definable limit (adj.).
14. Discharge Air Temperature: The controller shall monitor the discharge air temperature.
- a. Alarms shall be provided as follows:

- 1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
  - 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
15. Zone Humidity: The controller shall monitor the zone humidity.
- a. Alarms shall be provided as follows:
    - 1) High Zone Humidity: If the zone humidity is greater than 70% (adj.).
    - 2) Low Zone Humidity: If the zone humidity is less than 35% (adj.).
- C. Belt Press Exhaust Fans (EF-DW-002, EF-DW-003 and EF-DW-004), - on/off (typ)
1. Run conditions - continuous: the fan shall run continuously when the associated Belt Filter Press is operating.
  2. Fan: the fan shall run when commanded by Control Panel and shall be interlocked to run when the associated Belt Filter Press is operating.
  3. Fan status: the controller shall monitor the fan status.
    - a. Alarms shall be provided as follows:
      - 1) Fan failure: commanded on, but the status is off.
      - 2) Fan in hand: commanded off, but the status is on.
- D. Exhaust Fans (EF-DW-005 and EF-DW-001) - on/off (typ)
1. Run conditions - continuous: the fans shall run continuously when commanded.
  2. Exhaust Fan Control –
    - a. Occupied Summer Mode: the exhaust fans shall run when commanded on.
      - 1) The controller shall receive a signal that the space is above 85° F from the space sensor and the make-up air unit is operating at maximum speed, the fans shall be energized.
      - 2) Once the space temperature drops below 85° F the fans shall be deenergized
  3. Fan status: the controller shall monitor the fan status.
    - a. Alarms shall be provided as follows:

- 1) Fan failure: commanded on, but the status is off.
- 2) Fan in hand: commanded off, but the status is on.
- 3) Airflow Failure: Only if fan called to run.

E. Truck Bay: Supply Fan (SF-DW-003), Exhaust Fans (EF-DW-009 and EF-DW-010)

1. Run conditions - continuous: the unit shall run continuously.
2. Supply Fan Control – SF-DW-003
  - a. SF-DW-003 shall run continuously.
  - b. When the outdoor temperature is above 50° F and the space is occupied as determined by a signal from the lighting panel, the fan shall operate at high speed.
  - c. When the outdoor temperature is below 50° F and the space is unoccupied as determined by a signal from the lighting panel the fan shall operate at low speed.
3. Exhaust Fan Control –
  - a. EF-DW-009: The exhaust fan shall run continuously in summer and normal mode.
  - b. EF-DW-010: The exhaust fan shall run continuously.
  - c. Unoccupied Mode – Winter: when the outdoor temperature is below 50° F and the space is unoccupied as determined by a signal from the lighting panel, EF-DW-009 shall be commanded off.
4. Alarms shall be provided as follows:
  - a. SF-DW-003 – Airflow failure.
  - b. EF-DW-009 - Airflow failure while in summer or normal mode only.
  - c. EF-DW-010 – Airflow failure.
5. Fan status: the controller shall monitor the fan status.
  - a. Alarms shall be provided as follows:
  - b. Fan failure: commanded on, but the status is off.
  - c. Fan in hand: commanded off, but the status is on.



- d. Fan runtime exceeded: fan status runtime exceeds a user definable limit (adj.).
- F. Air Conditioning Units: AC-DW-001, CU-DW-001 and AC-DW-002, CU-DW-002
1. Run conditions – intermittent to main space temperature.
  2. The air conditioning units shall be controlled by factory supplied controllers.
  3. Cooling Mode: The unit controller shall start/stop the air handling unit fan, control air handling unit fan speed, start/stop compressor and condensing unit fan as needed to maintain the space cooling set point determined by the remote thermostat within the space.
  4. Heating Mode: The unit controller shall start/stop the air handling unit fan, control air handling unit fan speed, start/stop and stage the heat pump as needed to maintain the space heating set point determined by the remote thermostat within the space.
  5. The unit controller shall have the necessary safeties to protect the unit in both heating and cooling operation.
  6. The outside air damper associated with AC-DW-001 shall be open whenever the unit is operating in heating or cooling mode. The damper shall be closed when the unit is not operating.

**END OF SECTION**

**SECTION 23 29 23**  
**VARIABLE-FREQUENCY DRIVES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes variable-frequency AC drives (VFDs).

**1.2 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 23 05 00, Basic HVAC requirements
- B. Section 23 05 93, HVAC testing, adjusting and Balancing
- C. Section 23 09 00, HVAC Automatic temperature Controls
- D. Division 26, Electrical

**1.3 REFERENCES**

- A. IEEE: Institute of Electrical and Electronics Engineers
  - 1. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- B. NEC: National Electrical Code
- C. NEMA: National Electrical Manufacturers Association

**1.4 SUBMITTALS**

- A. For systems, equipment, and components specified herein, submit product/material data; shop drawings; operation and maintenance data; as-constructed data; installation, startup, and testing manuals; operation and maintenance manuals; and as-constructed drawings.
  - 1. Product Data: Include dimensions, weight, schematic and single-line diagram, total harmonic distortion (THD), standard functions, features, capacities, and details of construction.
- B. For systems, equipment, and components specified herein, submit commissioning plans and schedules; checkout, startup, operational, functional and final acceptance test plans, procedures, checklists, and reports; systems manuals; and operation and maintenance training plans.

## 1.5 WARRANTY

- A. VFDs shall have a minimum warranty of 12 months from the date of certified startup and not less than 18 months from date of manufacture. The warranty shall include all parts, labor, travel time, and expenses. The Contractor shall inform the Port of any extended warranty programs offered by the manufacturer for consideration by the Port.
- B. The Contractor shall coordinate with the VFD manufacturer and be responsible for the VFD warranty and all VFD problems incurred during and after installation at the work site, as well as provide and warranty any individual VFD units sent to the manufacturer for required equipment run testing. Supply technical assistance during testing at the manufacturer's factory, coordinate shipping, and pay for all costs.

## PART 2 - PRODUCTS

### 2.1 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Acceptable Manufacturers: ABB, no substitutions.
- B. General Description:
  - 1. AC motor variable frequency controller (VFC) shall be of pulse width modulated (PWM) inverter type. The VFC shall be designed to convert 60 Hz input power to adjustable frequency output power to provide positive speed control to standard induction motors. The VFC shall be dedicated variable torque design for specific use with centrifugal loads.
  - 2. Provide complete solid state variable frequency power and logic unit.
  - 3. Frequency control shall be stepless throughout the range under variable torque load on a continuous basis. Frequency controlled by remote building energy management system providing 4-20MA input signal to drive and remote start/stop signal. Coordinate with other work of Division 23.
  - 4. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.
  - 5. Each VFD shall contribute no more than 5 percent total harmonic voltage distortion at the VFD input terminals while operating under full-load conditions. If proposed VFD equipment is anticipated to exceed these limits, multi-pulse converters and/or harmonic filtering devices shall be provided.
  - 6. Design and manufacture equipment in accordance with applicable NEMA and IEEE recommendations and be designed for installation in accordance with NEC. Equipment shall have UL and/or CSA approval.
  - 7. Control shall be suitable for operation in ambient temperatures of 0 to 40°C.
  - 8. Every VFD shall be factory tested with an AC induction motor 100 percent loaded and temperature cycled within an environmental chamber at 104°F.
- C. Self Protection and Reliability Features:
  - 1. Adjustable current limit from 60 to 110 percent of drive rating.
  - 2. Adjustable instantaneous over current trip.
  - 3. Under voltage trip.

4. Over temperature trip.
5. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
6. Momentary power loss, more than 17 milliseconds.
7. Transient protection against all normal transients and surges in incoming power line.
8. Orderly shutdown in event of any of above conditions, drive shall be designed to shut down safely without component failure.
9. Provide visual indication and manual reset.

D. Standard Features:

1. Drive logic shall be microprocessor based. Control logic shall be isolated from power circuitry.
2. Standalone operation to facilitate startup and troubleshooting procedures.
3. VFD shall have a lockable circuit breaker disconnect and be UL 508C listed for use on distribution systems with 22,000 AIC.
4. Door interlock protection which shall be defeatable by qualified personnel to troubleshoot during operation as required.
5. Input power 460V 60 Hz, 3-phase output voltages shall be equal to applied input voltage.
6. Isolated signal inputs.
7. Frequency Stability: Output frequency shall be held to +0.1 percent of maximum frequency regardless of load, +10 percent input voltage change or temperature changes within ambient specification.
8. Built-in digital display located in panel face shall indicate output frequency, voltage and current and shall provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, and fault condition.
9. Start/Stop Control: Controlled decelerated stop.
10. Primary and secondary fused for a control circuit transformer.
11. Minimum and maximum speed control.
12. Adjustable Accel/Decel: Independently adjustable 10-100 second.
13. Hands-off auto switches.
14. Programmable auto restart after power outage.
15. Fused disconnects shall include auxiliary contacts to isolate control circuit when disconnect is in "off" position.
16. Remote contacts for fault, and on/off status.
17. Adjustable motor output voltage.
18. Analog output voltage of 0-10 VDC, 4-20MA proportional to control output frequency.
19. RS232 communications port, and programming software capability.

E. Additional Features:

1. NEMA 1 enclosure shall isolate each motor starter and control section with its associated disconnect switch.
2. Manual speed control for each motor.
3. Manual bypass shall provide ability to service control while motor is operational.
4. Provide radio frequency and electromagnetic interference noise suppression network to limit radio frequency and electromagnetic interference.

5. Provide isolated analog output signals for volts, amps, and frequency, from each VFD for connection to the building energy management system.
  6. Provide line (input) reactors.
  7. Provide output filters for all VFD's located more than 150 conductor feet from the motor they serve.
  8. VFD shall be designed to catch a spinning load in forward and reverse direction.
  9. Perform harmonic calculations on a manufacturer-supplied harmonic analysis program for conformance with IEEE 519.
- F. CSA, ETL, or UL label.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Coordinate with the VFD manufacturer to provide and be responsible for all coordination, application engineering, and startup support to ensure that the VFD is properly selected for each piece of equipment.

#### **3.2 VARIABLE SPEED CONTROLLER INSTALLATION**

- A. Mount on walls in accordance with the manufacturer's instructions.
- B. Coordinate input/output power connections with Division 26.
- C. Coordinate control signal with other work of Division 23.
- D. Provide startup service by factory authorized technician.

#### **3.3 COMMISSIONING**

- A. Commission systems, equipment, and components specified herein.

#### **3.4 TESTING**

- A. Check out, start up, and test systems, equipment, and components specified herein.
- B. The Port reserves the right to witness any or all of the aforementioned tests. Provide notice at least 24 hours before testing.
- C. Provide, at no additional cost to the Port, any technical assistance or support to ensure the proper testing/performance of the VFD and of the system as a whole. This includes programming of the VFD to coordinate with the manufacturer's operating requirements. Allow 2 hours of startup time per VFD.

- D. Provide complete programming information for startup for each VFD. Provide these parameters in writing to the Port prior to the startup of the VFD and cover the protection, ramp up, ramp down, carrier frequency, and all other necessary parameters.

**END OF SECTION**

**SECTION 23 31 13**  
**METAL DUCTS AND DUCT ACCESSORIES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install all ductwork, fittings, and accessories as shown on the Drawings and in accordance with the Specifications.
- B. The equipment shall be furnished complete with all accessories, special tools, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a complete installation.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 23 00 00 – Basic HVAC Requirements
- B. Section 23 05 93 – HVAC Balancing

**1.03 SUBMITTALS**

- A. The Contractor shall submit shop drawings on all new and modified ductwork, accessories and appurtenances and all fabrication work required for all equipment specified in this Section in accordance with Section 01 33 00 – Submittal Procedures.
- B. The Contractor shall submit shop drawings for supports for new and modified ductwork. The shop drawings shall locate and identify each support, brace, hanger, guide, component and anchor. Ductwork support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the State or Commonwealth in which the project is located and shall comply with Section 01 73 23 – Seismic Anchorage and Bracing and Section 23 05 48 – Vibration and Seismic Controls for HVAC.
- C. The Contractor shall submit shop drawings for support of multi-section dampers and louvers. The shop drawings shall identify all supports and reinforcement required to allow the multi-section dampers and louvers to be rated for the maximum pressure of the individual damper and louver sections. The support system shall be designed and calculations prepared and sealed by a Registered Professional Engineer in the State or Commonwealth in which the project is located.

**1.04 WARRANTY AND GUARANTEE**

- A. Warranty and Guarantee period shall be for two (2) years.

## **PART 2 – PRODUCT**

### **2.01 GENERAL REQUIREMENTS**

- A. All work shall be constructed and installed in a first-class workmanlike manner in accordance with the recommendations given in the latest edition of the Sheet Metal & Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards and Round Industrial Duct Construction Standards, unless otherwise specified.
- B. All ductwork shall be constructed in accordance with the Schedule of Duct Construction Standards listed on the last page of this Section. Transverse duct connections shall be bolted, gasketed connections.
- C. All ducts shall conform accurately to the dimensions indicated on the Drawings, shall be straight and smooth on the inside with neatly finished joints, and shall not be decreased at any point to avoid obstructions. No piping, conduit or structural work shall be installed in or through any ductwork. All ductwork shall be run as close as possible to structural members, walls and ceilings. Duct work shall be as shown on the drawings, subject to such modifications as may be necessary to suit field conditions.
- D. Where existing walls, floors or roofs must be penetrated, the Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.
- E. All ducts shall be made reasonably tight throughout and shall have no openings other than those required for the proper operation and maintenance of the systems.
- F. Minimum thickness for metal ducts shall be per SMACNA guidelines, but in no instance shall be less than 20 gauge for steel ducts and 14 gauge for aluminum ducts.
- G. Supports for ducts shall be provided and securely fastened in place at every change in direction and as required to prevent deflection.
- H. Changes in size of ducts shall be by means of a taper transformation piece, the included angle of the taper being not more than 20 degrees.
- I. All duct work joints shall be sealed to achieve a SMACNA Seal Classification Rating as indicated in the ductwork schedule of this specification.
- J. The weight of material used for ducts and stiffeners, the fabrication methods, cross breaking of flat duct surfaces, and assembling of the ductwork shall conform to the Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. Beaded duct construction shall not be used.



- K. All duct panels shall be braced or reinforced as necessary, in addition to the minimum requirements in the ASHRAE Guide, to eliminate vibration and noise and to prevent deflection from the indicated shapes and dimensions.

## **2.02 STAINLESS STEEL AND ALUMINUM DUCT**

- A. Ductwork material shall be as indicated in the duct schedule in Part 3 of this specification.
- B. Stainless Steel: ASTM A480/A480M, Type 316 having a number 2D finish for all applicable ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements and shall be properly protected where subject to mechanical injury.
- C. Aluminum: ASTM B209, alloy 1100, 3003, or 5052 for all applicable ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements and shall be properly protected where subject to mechanical injury.
- D. Transverse duct connections for rectangular ducts shall be bolted, gasketed connections made with standard Ductmate 35 System as manufactured by Duct Mate Industries, W.D.C.I. or approved equal. All longitudinal seams shall be Pittsburgh Z, or better. Duct flange system material shall match the duct material. Gaskets shall be suitable for exposure to hydrogen sulfide 2ppm.
- E. Transverse duct connections for round ducts shall be bolted, gasketed connections in accordance with chapter 12 of SMACNA Round Industrial Duct Construction Standards. Duct connections shall be the same material as the duct. Utilize longitudinal seam ductwork. Gaskets shall be suitable for exposure to hydrogen sulfide 2 ppm and outdoor use.
- F. All ductwork shall be shop fabricated in sections with flanged ends. The Ductmate 35 flange system shall be factory spot welded to the ductwork. No field welding of ductwork shall be permitted. Welding equipment and electrodes shall be of a type specifically suited for welding light gauge 316 stainless steel or aluminum, as applicable, to provide consistently good quality welds.
- G. All duct sections shall be constructed and installed without forming dips and traps.
- H. All ducts shall have a minimum clearance of three (3) inches from all combustible material.

## **2.03 HANGERS AND SUPPORTS**

- A. All ductwork shall be securely hung and anchored to the building structure. Unless otherwise shown or specified, hangers and stiffeners for ducts shall conform with the recommendations given in the SMACNA HVAC Duct Construction standards and

SMACNA seismic restraint manual. Ducts shall be supported on trapeze hangers consisting of angles and rods. Use of strap hangers and straps is prohibited.

- B. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall be constructed of the same material as the ductwork that it supports.
- C. All ductwork shall be supported from trapeze type hangers. Stainless steel hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and 1/2 inch diameter for all ducts with half perimeter larger than 72 inches. Aluminum hanger rods shall be of sufficient diameter to achieve the equivalent strength of the stainless steel hanger rods for the sizes indicated. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches.
- D. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.
- E. Support shall be furnished at each fitting. Material of supports shall match duct material.
- F. Seismic & Wind Requirements: All ductwork shall be provided with seismic and wind restraints in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, as published by SMACNA, in accordance with the International Building Code, the indicated design wind speed, and ASCE-7 to the extent that the most stringent provisions are utilized. Material of seismic and wind restraints shall be as specified herein. A calculation signed and sealed by a Registered Professional Engineer in the State or Commonwealth in which the project is located shall be provided verifying that the installed supports meet the seismic and wind requirements. See Section 01 73 23 – Seismic Anchorage and Bracing and Section 23 05 48 – Vibration and Seismic Controls for HVAC and the Structural Design Drawings for additional details and requirements.

## 2.04 ACCESSORIES

- A. Manual Volume & Backdraft Dampers in Rectangular Stainless Steel or Aluminum Duct:
  - 1. Manufacturer: Provide products of one of the following:
    - a. Greenheck
    - b. Ruskin
    - c. Nailor
    - d. or equal
  - 2. Frame, blade, axle, bearings, jamb seal, and linkage materials: Match ductwork.

3. Blades:
    - a. Opposed blades for volume dampers and parallel blades for backdraft dampers;
    - b. Vinyl edge seals, thermoplastic elastomer seals for corrosive/chemical services.
  4. Damper shafts shall be solid hexagonal or square shape.
  5. Linkage shall be concealed in damper frame.
  6. Provide outside handle, quadrant and approved position indicator and locking device on volume dampers.
  7. Reference: SMACNA Standards.
- B. Backdraft Dampers in Round Stainless Steel or Aluminum Duct:
1. Manufacturer: Provide products of one of the following:
    - a. Ruskin
    - b. Greenheck
    - c. Nailor
    - d. Or equal
  2. Frame, blade, axle, bearings: Match ductwork
  3. Damper shall be of the two blade design mounted on separate axles and shall be suitable for horizontal or vertical installations
  4. Blades shall be retained in the closed position by a tensioned spring. The spring shall be field adjustable
  5. Seal shall be a vinyl foam
- C. Stainless Steel Motorized Dampers:
1. Manufacturer: Provide products of one of the following:
    - a. Ruskin
    - b. Greenheck

- c. or equal
  2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 316 Stainless Steel.
  3. Blades:
    - a. Opposed blades (control) and Parallel blades (shut-off)
    - b. Vinyl edge seals, thermoplastic elastomer seals for corrosive/chemical services.
  4. Damper shafts shall be solid hexagonal or square shape.
  5. Actuators shall be externally mounted to the damper and shall be a minimum of NEMA 2. All actuators shall be enclosed in a NEMA 4X case unless otherwise specified. Actuators located in classified spaces shall be enclosed in a NEMA 7 case unless otherwise specified.
    - a. For actuator requirements, see the following:
      - 1) Section 23 09 00 – HVAC Automatic Temperature Controls (BMS Logic).
  6. Damper leakage rate shall not exceed 3 cfm/sq. ft. at 1" w.g.
  7. Reference: SMACNA Standards.
- D. Aluminum Motorized Dampers:
1. Manufacturer: Provide products of one of the following:
    - a. Ruskin
    - b. Greenheck
    - c. Or equal
  2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 6063T5 Aluminum
  3. Blades:
    - a. Opposed blades (modulating control) and Parallel blades (2 position shut-off)
    - b. Neoprene blade edge seals and flexible metal compressible jamb seals.
  4. Damper shafts shall be solid hexagonal or square shape.

5. Actuators shall be externally mounted to the damper and shall be a minimum of NEMA 2. All actuators shall be enclosed in a NEMA 4X case unless otherwise specified. Actuators located in classified spaces shall be enclosed in a NEMA 7 case unless otherwise specified.
6. Reference: SMACNA Standards.

E. Registers and Grilles:

1. Manufacturer: Provide product(s) of one of the following:
  - a. Titus (Basis of Design, model numbers scheduled on drawings)
  - b. Anemostat
  - c. Price Industries
  - d. Nailer Industries, Inc.
  - e. Hart and Cooley.
2. Units shall be factory-fabricated of Type 316 stainless steel construction for stainless steel and FRP ductwork and aluminum for aluminum ductwork. They shall distribute the specified air volume (cubic feet per minute).
3. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance.
4. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers.
5. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.
6. An additional volume damper shall be installed in duct stub to each air outlet for balancing of air volume.
7. Supply Registers:
  - a. Supply registers shall be double deflection type, complete with adjustable vertical face bars and a key operated opposed blade damper.
8. Air extracting devices shall be installed at all collar take-offs to supply registers. The air extracting devices shall have two sets of individually adjustable blades to

equalize flow and control volume at collar takeoffs and shall be gasketed around the perimeter.

9. Exhaust and Return Registers and Grilles:
  - a. Exhaust and return registers shall be furnished with fixed vertical face bars, set straight, and a key operated opposed blade damper.
- F. Duct-Mounted Access Doors and Panels:
  1. Provide access doors at all duct connections dampers for access and maintenance of damper motor actuators and linkages.
  2. Fabricate doors and panels airtight and suitable for duct pressure class.
  3. Seal around frame attachment to duct and door to frame with neoprene.
  4. Door and frame to be of same material as duct.
- G. Flexible Connectors unless indicated otherwise shall meet the following requirements:
  1. Self-extinguishing material shall meet NFPA 90A, NFPA 701 and UL-214 Standards.
  2. Material:
    - a. Commercial grade neoprene coated woven fiberglass, Proflex by DUCTMATE, or approved equal.
    - b. Corrosion/chemical resistant applications shall be of Teflon coated woven fiberglass fabric. Minimum density 18 oz./sq. yd. and rated to 500 F.
  3. Extra wide edge connectors factory fabricated with a strip of fabric. Material of connectors shall match duct material.
- H. Instrument Test Holes: Material to suit duct material, including screw. Size holes to allow insertion of pitot and other testing instruments, and length to suit duct insulation thickness.
- I. Turning Vanes:
  1. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically.

2. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible" Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted.
3. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer's instructions.

#### J. Drip Pans

1. Drip pans shall be welded 16 gauge, type 316 Stainless Steel.
2. Drip pans shall extend 2" beyond the dimensions of the equipment of ductwork above on all sides.
3. Drip pan shall have a minimum 1" lip.
4. Drip pan shall be sloped to a ¾" copper type L drain line such that pooling or standing water is prevented. The drain shall be continuously sloped a minimum of 1/8" per foot. The drain shall terminate 6" above the sink or nearest floor drain.
5. Provide a dielectric coupling between the stainless steel drip pan and copper drain line to prevent contact between dissimilar metals.
6. Contractor shall coordinate drip pan supports with the existing structural construction above. The Contractor shall provide all supplemental beams and channels needed. The support system shall be capable of supporting the weight of a full drip pan plus an additional 300 lb. load.
7. See Section 23 05 93 – HVAC Balancing for drip pan testing procedures.

### 2.05 DUCT INSULATION

- A. Refer to Section 23 07 00 – HVAC Insulation.

## PART 3 – EXECUTION

### 3.01 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.
- B. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. Where possible, store ductwork inside and protect from weather. If necessary to store outside, store above grade and enclose with waterproof wrapping.

### 3.02 INSTALLATION OF DUCTWORK

- A. Examine areas and conditions under which ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Assemble and install ductwork in accordance with recognized industry practices, Manufacturer's installation instructions, and SMACNA standards to achieve the seal and leakage classes indicated in the Duct Construction Table at the end of this specification.
- C. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.
- D. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- E. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.
- G. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 3" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings.
- H. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- I. Turning vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation. Vanes shall be installed in all short radius elbows in accordance with SMACNA Duct Construction standards.
- J. The dial regulators for manual volume dampers shall be marked so that the "open" and "shut" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that sheet metal fasteners do not protrude into the duct and interfere with



damper operation. Volume dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split.

- K. Duct access doors shall be provided before and after duct mounted coils, within working distance of, and on the fusible link side of all fire dampers, adjacent to volume dampers, on the linkage side of automatic dampers, duct mounted sensors, and at all other apparatus requiring service or inspection in the duct system. Access doors shall be a minimum of 15 x 18 inches; where the size of the duct will not accommodate this size the doors shall be made as large as practical. The doors shall be rigid and airtight, and provided with neoprene gaskets, hinges and sash locks. Whenever space requirements are such that a hinged access door is impractical, a screw fastened lift-out door shall be provided instead.
- L. Test openings shall be installed in the ductwork at the points listed below. The test openings shall be a minimum of 3/8" and shall be sealed by a screw cap and gasket, and shall be installed so that the insulation is not disturbed when the cap is removed. The test openings shall be located as follows in all heating, ventilating, air conditioning, and dehumidification systems:
1. Upstream and downstream of each coil, duct heater, filter bank, or other inline equipment that heats, cools, humidifies, dehumidifies, or filters air.
  2. In the outside air, supply, and return ducts adjacent to the respective connections on all AHUs, HVs, DHUs, etc.
  3. In the main supply duct on single zone units and in each zone supply duct on multizone units
  4. As indicated on the Contract Drawings
- M. Air filter gauges for measuring the differential pressure through all filter banks shall be supplied and installed; one gauge shall be installed for each bank. The gauge shall be of the inclined tube differential type complete with 1" thick acrylic plastic body, mirror-polished scale, built-in level vial, over pressure safety traps, signal flags, 2 vent valves for zeroing gauge, 2 static pressure tips, two 5-foot lengths of 1/4" stainless steel tubing, 2 compression fittings, mounting hardware, a bottle of red gauge oil and instructions. The gauges shall have a range of 0-1.0 inch water column with minor divisions of .02 inch water column.
- N. The Contractor shall install prefabricated roof curbs before the installation of roofing.
- O. All air outlets shall be with rigid connection to the ductwork.

- P. After the installation is completed, the Contractor shall seal all joints air tight. Sealants and tape shall have a flame spread not greater than 25 and a smoke developed rating of not over 50 per ASTM E-84.

**3.03 DUCT LEAKAGE TESTS**

- A. Test duct per SMACNA HVAC Air Duct Leakage Test Manual.

**3.04 DAMPER AND LOUVER INSTALLATION**

- A. The Contractor shall install dampers and louvers per the manufacturer’s installation instructions.
- B. The Contractor shall install all reinforcement required for multi-section dampers and louvers to all the assembly to withstand the rated velocity and pressure of the individual damper and louver sections.

**3.05 EQUIPMENT CONNECTIONS**

- A. Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated in the Contract Drawings and Specifications.

**3.06 ADJUSTING AND CLEANING**

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

**3.07 DUCT MATERIAL AND CLASSIFICATION**

**Duct Construction Schedule**

Service	Pressure Class	Duct Material	Seal Class	Leakage Class	Construction Standards
Supply (All areas)	+/- 2 inwg.	316 Stainless Steel or Aluminum	A	12	SMACNA HVAC Duct Construction Standards
Exhaust (All areas excluding	+/- 4 inwg.	316 Stainless Steel or Aluminum	A	6	SMACNA HVAC Duct Construction Standards

**Duct Construction Schedule**

<b>Service</b>	<b>Pressure Class</b>	<b>Duct Material</b>	<b>Seal Class</b>	<b>Leakage Class</b>	<b>Construction Standards</b>
dewatering exhaust)					

**END OF SECTION**

**SECTION 23 31 16**  
**NONMETAL DUCTS AND DUCT ACCESSORIES**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. This Section shall govern the materials, fabrication, and installation of FRP ductwork that is used for the purposes of conveying air associated with heating, ventilation, and air conditioning systems shown on the HVAC Design Drawings. This Section shall not govern FRP ductwork associated with any odor control duct or ductwork shown on the Mechanical Design Drawings.
- B. Contractor shall furnish any and all labor, materials, equipment, services and incidentals required to field measure, install, field test, complete and place in satisfactory operation all Fiberglass Reinforced Plastic (FRP) ductwork contained in this Section as shown on contract drawings and as specified herein.
- C. Contractor shall be system supplier, where ductwork Manufacturer's professional engineer shall provide Contractor with complete materials and mechanical engineering necessary to satisfy all ductwork design requirements of this Section.

**1.02 RELATED WORK**

- A. Section 23 00 00 – Basic HVAC Requirements
- B. Section 23 31 13 – Metal Ducts and Duct Accessories
- C. Section 23 05 93 – HVAC Balancing

**1.03 REFERENCES**

- A. The most recently published standards at time contract to manufacture fiberglass ductwork are entered into shall govern requirements imposed on the Manufacturer.
- B. In the event of conflict, inconsistency or ambiguity between these references and the specific project requirements, the following order of precedence shall govern where laminate quality, dimensional accuracy and conformance to this specification are brought into question:
  - 1. This ductwork specification Section.
  - 2. Contract drawings.
  - 3. References within this Paragraph 1.3, where:

- a. ASTM D2563 definitions shall take precedence over ASTM C582 for types and quantity limitations.
  - b. ASME RTP-1 Parts NM-2 Design of Integral Body Flanges and NM-12 FRP Flange Design shall take precedence over ASTM D3982, D3299 and D5421.
- C. Building Codes:
1. International Building and Energy Conservation Code
- D. Air Movement and Control Association (“AMCA”):
1. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
  2. AMCA 511 - Certified Ratings Program for Air Control Devices.
- E. American Society of Mechanical Engineers (“ASME”):
1. ASME RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment
- F. American Society for Testing and Materials (“ASTM”):
1. ASTM C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
  2. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics.
  3. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics.
  4. ASTM D883 - Standard Definition of Terms Relating to Plastics.
  5. ASTM D2471 - Standard Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins.
  6. ASTM D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
  7. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics By Means of a Barcol Impressor.
  8. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
  9. ASTM D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

10. ASTM D3982 - Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermoset Resin) Ducts.
11. ASTM D5421 - Standard Specification for Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges.
12. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

#### 1.04 DEFINITIONS

##### A. General:

1. The term "Manufacturer" where used in this Section, refers to the entity which designs, engineers, fabricates and provides quality control and field inspection services for ductwork provided under this Section.
2. The term "Resin Supplier" where used in this Section, refers to the entity which produces resin for distribution.
3. Acronyms:
  - a. "Bis-A" is "Bisphenol-A"
  - b. "CA" is "Corrosion Allowance"
  - c. "CB" is Corrosion Barrier
  - d. "CoNap" is "Cobalt Napthinate"
  - e. "EVER" is "Epoxy Vinyl Ester Resin"
  - f. "FR" is Fire Retardant
  - g. "MEKP" is "Methyl Ethyl Keytone Peroxide"
  - h. "OS" is Outer Surface
  - i. "PE" is "Polyester"
  - j. "SL" is Structural Layer
  - k. "SS" is "Stainless Steel"
  - l. Standard definitions of terms relating to FRP as described in ASTM D883.

##### B. Design:

1. ASTM D2563 definitions for types and quantity limitations of visual defects.
2. Minimum dimensions: Where minimum dimensions are specified in reference standards and this Section, the dimensions specified shall include any tolerances allowed by industry standards and shall be interpreted as absolute minimums for purposes of determining compliance with this Section. Such minimum dimensions shall not be construed to be in lieu of engineering calculations or demonstration of design as required of Manufacturer per this Section.
3. Corrosion allowance: Where a corrosion allowance is specified in this Section it shall be interpreted to require that thickness of inner corrosion barrier specified shall be added to minimum structural thicknesses shown within industry standard tables or determined through use of industry standard rules, other design equations, stress analysis and lamination analysis. The thickness and physical properties associated with an inner corrosion barrier that is specified as a corrosion allowance shall not contribute to strength of material and be regarded as sacrificial layers. This additional thickness shall apply to all components possessing an inner corrosion barrier and outer corrosion barrier where such outer barrier is regarded as a wetted or process side surface. Thickness shown within industry standards shall be interpreted to mean structural layer thicknesses.

#### **1.05 SUBMITTALS**

- A. Detailed Manufacturer shop drawings, including:
  1. Ductwork dimensions for each major component and assembly, with all nozzles, joints and accessories located and dimensioned.
  2. Ductwork data table indicating sizes, thickness and weight, piece numbers, diameter, pressure rating, chemical service temperature limit and maximum allowable spans.
  3. Construction details such as reinforcing ribs, transitions, reducers, elbows, access points, turning vanes, louvers, dampers plus FRP buildups, shear collars, flanges, lugs and pedestals used at support locations.
  4. Nozzle schedule with construction details demonstrating conformance to this specification. Schedule shall include nozzle mark number, flange inside and outside diameter, flange and neck thicknesses, attachment overlays, bolt circle diameter, number and diameter of bolt holes and recommended torque limits.
  5. Outside and inside overlay joint details such as width, thickness, taper and material composition plus field trim allowance at field joint locations. Identify shop and field joint locations.

6. Identification of materials of construction for all components.
  7. Support arrangement, with recommended anchoring and guiding methods.
  8. Location, materials of construction, connection method and dimensions for:
    - a. Gaskets and fasteners.
    - b. Expansion/contraction joints.
    - c. Dampers and louvers.
    - d. Other accessories.
  9. Location of permanent and temporary labeling as required by this Section.
  10. Any and all drawing revisions shall be clearly identified and noted within drawing title block, where a delta symbol with revision number inside triangle shall be placed alongside any and all drawing changes made under the revision so noted. As each drawing revision is released for review, such notations shall be shown in red with prior revision notations shown in black.
- B. Detailed Contractor supplied drawings, including:
1. Support, anchor, guide and restraint FRP dimensions for coordination with Manufacturer's related engineering and shop drawings plus installation by Contractor as required per this Section.
- C. Data requirements, including:
1. Design calculations substantiating support, anchor, guide and restraint FRP shapes required for the ductwork support system.
  2. Manufacturer's ductwork catalogs, descriptive literature and specifications.
  3. Manufacturer's design report shall include descriptive language, calculations and stress analysis substantiating materials shown on Manufacturer's drawings, including:
    - a. Ductwork wall thickness.
    - b. Reinforcing ribs and locations.
    - c. Flanges over 36-in diameter or 120-in perimeter in the case of rectangular flanges.
    - d. Support spans plus guide, anchor and restraint locations.



- e. FRP shear collars for vertical support and/or anchor interface.
  - f. Expansion and contraction, with loads at flexible connectors identified.
  - g. Color stress plots supporting pipe stress analysis where performed.
  - h. Any and all other such ductwork design calculations required to fulfill the requirements of this Section.
4. ASTM test records demonstrating proof of physical properties used in design calculations.
  5. List showing size and quantity of FRP shop and field joints required for installation.
  6. Specifications and details for:
    - a. Gaskets and fasteners
    - b. Expansion/contraction joints and flexible connectors
    - c. Volume and shutoff dampers and louvers
    - d. Corrosion coating for non FRP components
    - e. Other accessories
  7. Letter from Resin Supplier confirming laminate design specified within this Section and detailed on drawings is suitable for intended service.
  8. Permanent and temporary ductwork labels.
  9. Copy of Manufacturer's AMCA certification, which demonstrate dampers and louvers are certified according to 500-D and 511 standards.
  10. Manufacturer's Certificate of Proper Installation.
- D. Provide all submittals, including quality control documents such as:
1. In process and final inspection reports, including demonstration of material, dimensional and visual quality conformance to this specification. Reports shall include non-conformity and corrective action for any deviations found.
  2. Factory inspection and testing report:
    - a. Resin gel time testing per ASTM D2471
    - b. Visual inspection per ASTM D2563

- c. Barcol hardness per ASTM D2583.
  - d. Acetone sensitivity.
- E. Installation, Operation and Maintenance Manual shall include:
  - 1. Instructions for shipping, receiving, handling, storage, installation, FRP field butt wrap joints and flange connections.
  - 2. Material Safety Data Sheets for all materials included in FRP field butt wrap joint kits.
  - 3. Copy of Manufacturer's warranty statement for ductwork as required by this Section.
  - 4. Manufacture's recommend initial ductwork inspection interval.
- F. Contractor's procedures for:
  - 1. Chemical segregation, spill containment and placarding for hazardous material storage and use areas.
  - 2. Managing fiberglass dust and styrene emissions propagated through cutting, grinding and laminating operations conducted during installation.
- G. Contractor's field FRP work inspection and testing report:
  - 1. Alignment, pitch and fit up tolerances.
  - 2. Out of round or square tolerances.
  - 3. Resin gel time testing per ASTM D2471.
  - 4. Butt wrap joint tracking checklist, including surface preparation and material utilization.
  - 5. Visual inspection per ASTM D2563.
  - 6. Barcol hardness per ASTM D2583.
  - 7. Acetone sensitivity.

## 1.06 QUALITY ASSURANCE

- A. All design calculations, drawings and other engineering related submittals provided by Contractor and Manufacturer are to be stamped by a licensed Professional Engineer employed full time or contracted by the Contractor or Manufacturer.

- B. Reference to names of Manufacturers within this specification is for the sole purpose of setting a quality standard desired.
- C. To ensure standardization of appearance, Manufacturer's services, operations, maintenance, and all ductwork and fittings must be completely fabricated by a single Manufacturer. Outsourcing FRP ductwork components and contracting manufacturing labor is not permitted.
- D. Contractor shall provide systems complete and ready for use, do work in accordance with all federal, state and local codes and ordinances and arrange for all permits, inspections, tests and registrations necessary for satisfying safety, environmental and other requirements.
- E. This specification Section and related contract drawings provide a general description for ductwork, but do not include sufficient detail for design, fabrication, installation and startup. Contractor shall provide such equipment and services so that systems are complete and ready for operation.

#### **1.07 DELIVERY, STORAGE AND HANDLING**

- A. Manufacturer shall properly prepare and protect ductwork from damage under normal circumstances.
- B. Ductwork shall be shipped complete, with no fiberglass related laminating work, assembly or fabrication permitted outside of Manufacturer's facility other than field joints shown on drawings.
- C. Ductwork shipped horizontally shall be mounted on padded cradles of sufficient size to prevent damage and adequately support the ductwork circumference. Suitable skid or dunnage shall be provided for ductwork shipped in other orientations. Cradles, skids and dunnage shall stay with ductwork for protection prior to installation.
- D. Sufficiently cross brace openings to maintain roundness or squareness within standard tolerances. Plug or cover all openings to prevent entrance of undesirables such as dirt, water or debris.
- E. Protect all flange faces with securely fastened durable flat blinds, ensuring that blind covering material extends to or beyond flange edges. Blind material and attachment method shall not cause abrasion or delamination to any flange surfaces or bolt holes during shipping, storage or installation.
- F. Accessories not reliably attached to ductwork for transportation purposes and cradled or skidded shall be properly packaged and shipped to prevent damage. No nesting of smaller ductwork inside larger is permitted. No components or accessories are allowed to be shipped inside ductwork.

- G. Load ductwork on truck with sufficient clearances all around to eliminate potential adjacent interferences. Firmly secure and protect all freight to prevent shifting or other movement during transportation. Nozzles, lugs, brackets or other projections shall not be used for securing, lifting or rotating ductwork.
- H. Manufacturer shall properly package butt wrap field joint materials and supplies:
1. Each fiberglass butt and wrap field joint shall be individually packaged in a water proof container and labeled, with all reinforcement precut by the Manufacturer and properly sequenced in the package.
  2. Labeling shall designate size, location keyed to drawings and laminate sequence.
  3. One (1) extra kit per joint type and size shall be provided.
  4. Resin and Catalyst (hardener) shall be packaged and properly labeled in Department of Transportation (DOT) approved five (5) gallon or smaller pails. Separate pails must be provided for Inner Corrosion Barrier, Structural Layer and Outer Surface resin, Finish Coat resin and Paste used to fill allowable gaps at fit up of joints.
  5. An extra 35% more resin shall be supplied than theoretically required given butt and wrap kit resin to glass ratios.
  6. Resin shipped for field work shall have a minimum three (3) month shelf life, with non-consumed resin removed from the jobsite upon completion of the installation.
  7. A sufficient quantity of cups, brushes, stir sticks and rollers required shall be supplied by Manufacturer and bulk packaged. Cups and brushes shall be solvent resistant, whereas all materials shall be suitably sized for work to be performed.
- I. Skids and cradles shall be configured and oriented during transport for ease of offloading and handling at site with crane or lift truck.
- J. Store all field butt wrap joint materials and related supplies furnished by Manufacturer in an area that is dry, between 35 and 75°F for maximum shelf life, properly protected from humidity and away from any direct sunlight and potential source of ignition or fire.

#### **1.08 SEQUENCING AND SCHEDULING**

- A. Contractor shall make and submit to Manufacturer any and all field measurements confirming ductwork requirements plus support, anchor, guide and restraint details prior to Manufacturer's development of design, engineering calculations and drawings as required under Part 1.5 Submittals. Such information furnished by Contractor shall include identification of ductwork piece numbers, field joints and trim locations.

- B. Where Contractor directly procures and supplies material interconnected with ductwork, Contractor shall coordinate:
  - 1. As built outside diameter of ductwork FRP buildups with Contractor supplied support, anchor, guide and restraint steel products such that padded steel is fabricated to provide full contact with ductwork buildups as shown on Manufacturer's drawings.
  - 2. Results of Manufacturer thermal expansion and contraction plus seismic calculations with Contractor supplied steel products plus expansion joint and flexible connector manufacturers to assure ductwork system design compatibility such that loads are properly restrained and/or absorbed.
  - 3. Fit-up of Contractor supplied dampers and louvers, gaskets, fasteners and other such materials.
- C. Ductwork and related materials shall not be fabricated by Manufacturer until Engineer confirms receipt and acceptance of design calculations.
- D. Delivery of ductwork shall be planned such that existing or new openings shall be utilized for installation. Ductwork shall not be cut or otherwise modified to facilitate installation or accommodate obstructions.

#### **1.09 WARRANTY**

- A. Manufacturer's standard warranty shall warrant in writing that their products are free from defects in design, material and workmanship under normal use and service for a period of two (2) years commencing from date work under paragraphs 3.2 below is complete.

#### **1.10 TOLERANCES**

- A. All tolerances pertaining to measurements such as laminate thickness, glass content, Barcol hardness, flange face flatness and perpendicularity, ductwork roundness or squareness, location of fittings and accessories and overall dimensions shall meet the more stringent requirements of referenced industry standards or as referenced within this Section.

#### **1.11 MANUFACTURER'S REPRESENTATIVE**

- A. The Manufacturer shall provide services of their shop inspector for field inspection of ductwork supplied. This inspection must be performed after equipment installation and cleaning required by this Section. Independent sales representatives shall not be considered as substitutes for shop inspectors. The shop or third party inspector's work will be considered complete once requirements of Paragraph 3.2 are completed.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Contractor shall be responsible for determining and communicating to Manufacturer restrictions that may prevent proper installation of ductwork, including clearances required during handling, setting, anchoring, accessories installation and piping.

### **2.02 FIBERGLASS DUCTWORK**

- A. Provide all ductwork in accordance with this Section as shown on contract drawings and specified herein.
- B. FRP ductwork shall be designed and fabricated in accordance with ASTM D3982 and other references within this Section, unless otherwise permitted or required by this Section.
- C. Manufacturer's ductwork system design shall include the following requirements:
  - 1. Design calculations supporting ductwork component thicknesses, including all steel, expansion joint and flexible connector interface considerations provided by Contractor, applicable loads individually or in combination per requirements of this Section, federal, state and local building codes and best engineering practices.
  - 2. Physical properties used in all design calculations shall be developed and demonstrated following industry standard protocol.
  - 3. Ductwork wall thicknesses shall be suitably designed for all loads and spans with or without reinforcing ribs.
  - 4. All ductwork shall be designed and fabricated to span support spacing as required. Buckling between supports shall be taken into consideration through stress analysis.
  - 5. Ductwork wall thickness shall be suitably designed with reinforcing ribs incorporated where necessary to achieve span within acceptable deflection limits.
  - 6. Maximum allowable deflection for any size ductwork or span shall be limited to the lesser of 1/2-in or 1/2-percent of span under worse case operating and weather conditions.
  - 7. Thermal expansion and contraction calculations shall be made, with results used to adequately design ductwork to absorb related loads or communicate with expansion joint manufacturers for proper joint design. Material properties used in calculations shall be derived in accordance with ASTM D695 and D696.

8. Ductwork systems equal to or large than 48-in diameter for round and 168-in perimeter for rectangular shall be analyzed using formal Pipe Stress Analysis (PSA), such as Caesar II, ALGOR PipePak or equal. Stress shall be fully evaluated at all critical locations, including flanges, elbows, tees, wyes, hangers, supports, anchors and restraints.
  9. Flanges over 36-in diameter and 120-in perimeter in the case of rectangular flanges shall be designed per ASME RTP-1 NM-2 Design of Integral Body Flanges and NM-12 FRP Flange Design as is applicable. As a minimum, rectangular ductwork flange dimensions shall correspond to those of round ductwork having the same diameter as the longest side of the rectangular ductwork and rounded up if not equal.
- D. Manufacturer's design calculations supporting ductwork component thicknesses must include all applicable loads individually or in combination, where required by Paragraph 1.03 – References of this Section, design criteria listed below and best engineering practices:
1. Design pressure: As indicated in ductwork schedule in Part 3 of this submittal
  2. Wind: 100mph (for outdoor ductwork only)
  3. Expansion and contraction associated with temperature differential:
    - a. 0°F to 100°F
  4. Accumulation of snow, ice and/or water on ductwork: 30 lb/sq.ft
  5. Seismic: Section 01 73 23 – Seismic Anchorage and Bracing and Section 23 05 48 – Vibration and Seismic Controls for HVAC.
  6. Mechanical link seal force
- E. Ductwork construction shall be as follows:
1. Shop manufactured and assembled to fullest extent without need for permitted transportation thereby minimizing field assembly and field FRP butt wrap joints. A list showing size and quantity of FRP shop and field joints required for installation shall be submitted for approval.
  2. Reinforcing ribs:
    - a. Ribs must be installed at point of ductwork manufacture and located so as not to interfere with supports, hangers, anchors, restraints and other such interconnected or adjacent equipment, accessories, materials and building structures.

- b. No pultruded, extruded, formed, milled or welded plastic, metallic or wood structural shapes or mechanical fasteners are allowed.
  - c. Rib construction shall be detailed on shop drawings.
3. Flange connections:
- a. All connections to expansion joints, flexible connectors, fans, dampers, louvers, registers, grillwork, hatches, covers, tank vents, scrubber inlets, condensate drain piping, instrumentation or other equipment shall be flanged with 6-in projection where flange is not on a straight run of ductwork. Auxiliary equipment directly screwed into fiberglass ductwork is not allowed. Such flanged connections shall be full faced for proper seating with ductwork flanges.
  - b. Custom filler pieces or spacer rings will not be allowed between mating flanges.
  - c. Flanges shall be hand lay-up construction using Type I or II laminate composition per ASTM C582, with flat full face flange on straight Section or integrally molded construction. No filament winding, rotational molding, resin transfer, vacuum infusion, compression molding or casting of flanges is permitted. Flange face shall be textured by lightly hand sanding with block sander to remove surface gloss imparted by mold surface.
  - d. Flanges on straight run sections shall have no voids or filler material where pipe joins flange lay-up.
  - e. Nozzles incorporating ASTM D5421 flange requirements shall be integrally molded per ASTM D5421 Figure 1 Type A and flush type per ASTM D3299 Figure 7, where installation shall follow ASTM D3299 Figure 6 and 7 with structural overlay placed as All Exterior material.
  - f. Cutout reinforcement shall be provided per ASTM D3299 Article 7.3.2.2 and good engineering practices for all nozzle and branch connections.
  - g. All bolt holes shall be shop drilled by Manufacturer using calibrated template and back spot faced or otherwise formed for flat and parallel seating of SAE or ASME B18.22.1 Type A Narrow washer seat, with all flange exterior and machined surfaces resin finish coated. All sharp edges, corners and projections shall be removed. Randomly match drilling flanges in Manufacturer's shop or field drilling of any kind is not allowed.
  - h. Gussets shall be provided for nozzles 4-in and smaller and be Plate-Type or Conical-Type per ASTM D3299 Figures 4 or 5.



- i. Flange flatness, warpage, perpendicularity and cant tolerances specified within this Section shall be strictly adhered to. Flange faces refaced or machined to meet tolerances shall have the Corrosion Barrier fully included.
  - j. All flange bolts shall be torqued to values as recommended by Manufacturer.
4. Round ductwork:
- a. Reinforcing ribs:
    - 1) Ribs shall be laminated and formed to a suitable shape over core material. Rib core material shall impart a laminate shape suitable for stiffening ductwork consistent with design calculations submitted and not contribute to strength of material in calculations.
    - 2) Rib core materials shall be closed cell foam half round or trapezoidal shape with laminate overlay to meet design submitted.
  - b. Fittings:
    - 1) All fittings such as elbows, laterals, tees and reducers shall have the same internal dimensions as the adjacent ductwork.
    - 2) Fitting thickness and laminate composition shall be equal to design of ductwork cylindrical sections composed of Type I or II laminates per ASTM C582 that meet design basis of this Section. Minimum thickness for reducer and transition fittings shall be equal to or greater than the wall thickness of the ductwork constructed of the same Type laminate that is adjoined to the larger fitting opening.
    - 3) Standard Round Elbows up to 48-inch diameter shall have smooth radius with a centerline radius equal to 1-1/2 times the ductwork diameter. Short radius round elbows, where the centerline radius is less than 1-1/2 times the ductwork diameter, are not permitted.
    - 4) Mitered Elbows are permitted for ductwork 54-inch diameter and greater. Standard dimensions shall be as shown in ASTM D3982 Figure 4.
    - 5) The length of concentric and eccentric reducers shall be five (5) times the difference in diameter and not as shown in ASTM D3982 Figure 4.
    - 6) Branch connections shall be perpendicular or 45 degrees per ASTM D3982 Figure 4.

- 7) End caps for sizes ranging from 36" to 96" diameter shall be ASME dish with crown radius equal to duct diameter, knuckle radius equal to 6% of crown radius and straight flange.
- c. Flange connections:
- 1) Flange construction and dimensions shall meet ASTM D5421 for tank vent, condensate drain piping and instrumentation connections and D3982 for all other connections.
  - 2) Flanges on smaller end of reducers and transitions shall have a minimum of 6-in straight section to accommodate bolting, as shown for reducers in ASTM D3982 Figure 4 Standard Duct Dimensions.
  - 3) Flanges on all sweep elbows shall have a minimum of 6-in straight section to accommodate bolting and not as shown for elbows in ASTM D3982 Figure 4 Standard Duct Dimensions.
  - 4) Minimum flange thicknesses shall be 5/8-in for less than or equal to 8-in diameter and 3/4-in for 10-in to 36-in diameter. Thicknesses for flanges greater than 36-in diameter shall not less than 3/4-in thick. Minimum flange thickness shall be measured at bolt hole in washer seating area.
5. Rectangular ductwork and transitions:
- a. All rectangular ductwork, fittings, transitions and other such structures shall have integrally molded corners with radiuses. Corner radii for adjoining walls of less than or equal to 24-inch shall be 1/2-inch, 1-inch for adjoining walls between 24-inch and 48-inch and 1 1/2-inch for greater than 48-inch adjoining wall lengths. In no case shall rectangular or rectangular to round components or systems be fabricated from flat panels, with or without quartered pipe sections in corners, and joined by butt wrap joints. Care shall be exercised to assure corner radii thicknesses are maintained as a minimum, with additional plies added if required.
  - b. Reinforcing ribs:
    - 1) Ribs shall be laminated structural shapes such as angle, channel, tees or tube material and laminated to ductwork. Complete rib structural shape laminate and attachment method utilized shall contribute to strength of material in calculations. Adhesives may be used in place of laminating structural shapes to ductwork where Manufacturer in-house test data, design calculations and drawing details are submitted demonstrating reliability.

- 2) As an alternate to laminated structural shapes, ribs may be laminated and formed to a suitable shape over core material. Rib core material shall impart a laminate shape suitable for stiffening ductwork and not contribute to strength of material in calculations. Rib core materials shall be closed cell foam half round or trapezoidal shape with laminate overlay to meet design submitted.
  - 3) Rib shape shall be suitable for stiffening ductwork consistent with design calculations submitted.
- c. Flange Connections:
- 1) Flanges on smaller end of reducers and transitions shall have a minimum of 6-in straight section to accommodate bolting, as shown for reducers in ASTM D3982 Figure 4 Standard Duct Dimensions.
  - 2) Minimum flange thicknesses shall be 5/8-in for less than or equal to 28-in perimeter and 3/4-in for 36-in to 120-in in perimeter. Thicknesses for flanges greater than 120-in in perimeter shall not less than 3/4-in thick. Minimum flange thickness shall be measured at bolt hole in washer seating area.
  - 3) Bolt hole location and size shall be designed by the Manufacturer, shall straddle major centerlines and not exceed 4 1/2-in space between hole centerlines.
- d. Turning vanes:
- 1) Mitered elbows shall have Hand Lay-up quarter round shaped turning vanes with 3:1 tapered leading edges, with a radius equal to that of the centerline radius of the elbow.
  - 2) Each turning vane shall be composed of an all random strand mat construction, with a C-Glass Veil on both sides of the curved vane. A sufficient number of turning vanes shall be provided such that they are spaced no greater than 6-in apart. Each turning vane shall protrude through the fitting wall on both sides a minimum of 1.5-in, with a fiberglass overlay equal in thickness to the fitting wall laid up onto the entire projecting portion of the vane and the adjoining fitting wall a minimum of 1.5-in forming a seal and reliable attachment.
  - 3) Turning vane thicknesses shall be determined by design calculations given all design criteria and deflection limits defined above. Minimum vane thickness shall be 3/8-in.

- e. Tops of all outdoor exposed rectangular ductwork, fittings, transitions and other structures shall be sloped  $\frac{1}{4}$ -in per foot to shed water. Slope shall be shown on shop drawing submittal.
6. Access hatches shall be 12-in and 24-in diameter, where the larger size that can be accommodated on the ductwork shall be provided. One (1) hatch shall be located on the upstream side of each bank of turning vanes, damper, louver and fan. Hatches shall be flanged as specified within this Section and provided with flat or domed cover.
  7. FRP Threaded couplings and nipples:
    - a. Shall be installed following the same requirements as specified within this Section for nozzles of the same size or as indicated in the Design Drawings.
    - b. Outside surface of fittings that receive secondary attachment overlay shall be ground smooth with a contour providing mechanical lock and primed with Aprime 2 secondary bonding agent prior to fitting installation.
    - c. Thermoplastic and metallic couplings and nipples are not allowed.
  8. FRP shop and field butt wrap joints.
    - a. All ductwork joints shall be butt wrap per ASTM D3982 Article 9.2 Joints. The butt wrap minimum width including tapered edges shall be the greater of 6-in or sixteen (16) times butt wrap thickness. Bell and spigot joints may be used for alignment purposes only, whereas no adhesives are used and step from bell end to inserted spigot shall taper 6:1 with smooth butt wrap transition between joined Sections. All outer surfaces of joint overlays are to be coated with resin finish coat containing paraffin wax.
    - b. All gaps between mating edges of ductwork and fittings must be limited to the thickness of the adjoining material, not to exceed  $\frac{3}{8}$ -inch, and maximum offset of lesser of  $\frac{1}{4}$ -inch or two (2) times edge thickness divided by three (3) prior to application of paste and butt wrap joint material. Paste used to fill gaps shall not protrude more than  $\frac{1}{8}$ -inch past inner surface of ductwork, fitting or transition wall.
    - c. For round ductwork, joint minimum thickness and laminate composition shall be equal to design of ductwork cylindrical sections composed of Type I or II laminates per ASTM C582 that meet design basis of this Section. For rectangular ductwork, joint minimum thickness and laminate composition shall be equal to the thicker component being adjoined. Joint minimum thickness and laminate composition for reducer and transition connections shall equal the ductwork adjoined to the larger fitting opening.

- d. At least one (1) field butt wrap joint shall be provided for each change in direction and elevation, with a minimum of 6-in field trim included and shown on drawings by Manufacturer at each field joint location. Field joints shall also be located at dimension "H" from duct flange faces per ASTM D3982 Figure 4 Standard Duct Dimensions. Duct flanges mating with dampers, fans, flex connectors and other related equipment shall be properly aligned and reliably bolted together with no undue stresses prior to applying butt wrap joint material.
  - e. Adhesive joints are not permitted.
  - f. An inside overlay shall be provided for all accessible shop and field joints for ductwork greater than or equal to 20-in diameter for round or 72-in perimeter for rectangular ductwork. All accessible nozzle and branch connections shall be inside overlaid. Inside overlay composition and thickness shall be equal to Inner Corrosion Barrier specified, where width shall be 6-in minimum.
9. No joints in axial direction of ductwork straight run sections are permitted.
10. Ductwork support:
- a. All ductwork supports, anchors, guides and restraints shall be engineered and supplied by the FRP Manufacturer and coordinated with the Contractor. Contractor shall work with the Manufacturer to determine number, location and configuration of such supplied materials, so that proper support, restraint, fit-up and thermal expansion and contraction is accounted for in FRP ductwork system design provided by Manufacturer.
  - b. All support materials shall match the construction of the ductwork. Materials thicknesses shall be calculated by the FRP Manufacturer and submitted with the stress analysis. FRP support materials shall include but not be limited to threaded rods, nuts, channels, angles, and plates. Support components that cannot be fabricated from FRP such as beam clamps, concrete anchors that extend beyond the concrete surface such as studs, or other components exposed to the atmosphere in the space shall be 316 stainless steel and field coated with a corrosion resistant coating suitable for exposure to the chemicals and concentrations listed in Paragraph 2.3(B) of this specification.
  - c. Maximum support spacing shall be equal to or less than limits set forth in ASTM D3982 Table 1 Typical Spacing, unless otherwise engineered by Manufacturer given design loads and support spans specified herein, on contract drawings or Contractor field dimensions.
  - d. Vertical riser sections of ductwork shall be supported by FRP pedestals laminated to backside of elbow sections or FRP shear collars or lugs

designed to abut braced steel support rings where required. Riser clamps shall not be used to support FRP ductwork.

- e. Ductwork shall be reinforced at each support, hanger, anchor and restraint with a minimum 1/4-in FRP buildup. This reinforcement shall cover and extend 3-in beyond the support bearing surface. Buildups shall be flat, smooth and fully in contact with the support. A 1/4-in neoprene pad shall be placed between FRP and support and adhered to support. Contractor shall provide supports with sufficient dimensions to accommodate FRP collar and neoprene pad given ductwork tolerances specified in this Section.
- f. Supports shall provide a minimum of 180 degrees of uniform complete contact with round ductwork and full contact with bottom and top of rectangular ductwork. Minimum support widths for round ductwork shall be 2-in wide for duct less than or equal to 10-in, 3-in wide for duct 12-in to 20-in, 4-in wide for duct 22-in to 36-in, 8-in wide for duct 38-in to 48-in and 12-in wide for duct 50-in to 60-in diameter. Minimum support widths for rectangular ductwork shall correspond to those of round ductwork having the same diameter as the longest side of the rectangular duct when rounded up if not equal.
- g. Ductwork shall be supported to allow removal of inline devices without adding temporary support, where such devices may include dampers, louvers, expansion joints, flexible connectors and fans.
- h. Ductwork shall be supported within 12-in of duct free end where connected to flexible connections, expansion joints or equipment.

F. Ductwork Signage:

- 1. Each fabricated duct Section shall be temporarily labeled with a piece number corresponding to drawings for installation coordination. Labels shall be able to withstand weather and durable enough to stay affixed to the duct until such time installation is complete and they can be removed.
- 2. Manufacturer to furnish the following data on a waterproof permanent label laminated directly on the side of ductwork near access hatches or other prominent locations:
  - a. Manufacturer's name.
  - b. Date of manufacture.
  - c. Pressure and temperature rating.
  - d. Corrosion Barrier resin, cure system and surface veil type.

G. FRP workmanship:

1. No layout markings, scratches, dings, sharp resin cured glass fiber projections, sharp edges or corners, major color variation or significant resin finish coat inconsistencies will be permitted.
2. All cut or machined edges and exterior surfaces shall be de-burred, chamfered, smooth and resin finish coated.
3. Resin finish coat work shall be free of defects such as but not limited to pinholes, excessive or inadequate film build, dry spots, drips, runs, sagging, and foreign inclusions. Any such defects shall be removed from the coat and the coat reapplied. The finish coat must appear uniform.

H. Manufacturer shall clean ductwork inside and out prior to packaging for shipment, removing any and all mold release materials, temporary fabrication layout lines, dirt, dust, debris and other such undesirables.

**2.03 LAMINATE MATERIALS**

- A. Ductwork laminate construction shall be suitable to convey chemically laden odorous air typically found in and around wastewater treatment facilities. Chemicals present include Hydrofluosilicic Acid, Hydrogen Fluoride, and Sodium Tetrafluoride. These odorous compounds in the air conveyed may reach as high as 100 percent relative humidity.
- B. Laminate construction for ductwork shall have Class I flame spread rating for Structural Layer and Outer Surface with Class II Inner Corrosion Barrier per ASTM E84..

Laminate Specification	LS620 Amended
<b>Inner Corrosion Barrier (CB):</b>	
Laminate Type	I
Resin Content	70 to 75%
Resin	Brominated Bis-A EVER
Synergist for Fire Retardancy	None <sup>1</sup>
Fire Retardant per ASTM E84	Class II <sup>1</sup>
Cure	MEKP/CoNap
Contact Molding Process	Hand Lay-up or Spray-up
Inner Surface (Veil)	(1) Synthetic Polyester 10 mils (0.010")

<b>Laminate Specification</b>	<b>ISS20 Amended</b>
Interior Layer (Chop Mat)	86 mils 1.5 oz/sf
Inner Corrosion Barrier Thickness	96 mils (0.106")
CB is a Corrosion Allowance	Yes <sup>1</sup>
Visual Quality Standard	ASTM D2563 Level II
Bubble Defect Density Limits	4/sq in <sup>1</sup>
Maximum Percent Repair	3%
<b>Structural Layer (SL):</b>	
Laminate Type	Hand Lay-up, Spray-up or Filament Wound
Reinforcement Content	25 to 80%
Resin	Brominated Bis-A EVER
Synergist for Fire Retardancy	Antimony as Required
Fire Retardant per ASTM E84	Class I
Cure	MEKP/CoNap
Filament Winding Wind Angle(s)	As Required
Bedding Layer Following CB	22 mils (0.022") 1.5 oz/sf
Pigment	Yes <sup>1</sup>
Minimum Thickness	Per Spec & Design
<b>Outer Surface (OS):</b>	
Resin	Brominated Bis-A EVER
Synergist for Fire Retardancy	Antimony as Required
Fire Retardant per ASTM E84	Class I
Cure	MEKP/CoNap
Contact Molding Process	Hand Lay-up or Spray-up
Resin Rich Wax Coating	Yes
UV Light Protection	Yes
10 mil Glass Veil	Yes <sup>1</sup>



Laminate Specification	ISF20 Amended
Pigment	Yes
Minimum Thickness	15 mils (0.015")
<b>Visual Quality SL and OS:</b>	
Standard	ASTM D2563 Level II
Bubble Defect Density Limits	10/sq in 1/16" or 4/sq in up to 1/8"
Maximum Percent Repair	10.0%

C. Laminate design and construction shall include the following requirements:

1. Inner Surface shall be Hand Lay-up process incorporating surface veil specified in this Section and have 90% resin content.
2. Interior Layer shall be laminated utilizing the Hand Layup or Spray-up process. The chop reinforcement shall be random strand glass fiber chopped from continuous roving whereas the fiber will be of the same size and weight as 1-1/2 ounce per square foot random strand mat, with 70 to 75% resin content.
3. Inner Corrosion Barrier shall be regarded as a Corrosion Allowance. This layer sequence shall not be considered as contributing to the components strength when calculating the thickness of the Structural Layer. This design requirement applies to all components and attachment joint inside overlays. The Inner Corrosion Barrier shall be clear, whereas no catalyst colorant, pigment, paint or other additives are allowed that shall interfere with visual inspection. Additives such as surfactants and antifoaming agents are permitted for improved reinforcement wet out and air bubble release when such additives are named within resin supplier letter(s) confirming laminate design suitability for intended service.
4. Structural Layer shall be Hand Layup and/or Spray-up for all components, whereas Filament Winding may be utilized only for round ductwork with such wind angle determined by Manufacturer. Where Filament Winding is utilized, a nominal 22 mil layer of 1-1/2 ounce per square foot chopped strand glass or equivalent thickness of chop shall be applied as a bedding layer for first pass filament winding glass strands between the cured Inner Corrosion Barrier and Structural Layer.
5. Structural Layer shall have a minimum thickness as calculated by Manufacturer given application and 28 to no more than 80% reinforcement content, with structural thickness no less than minimums specified within ASTM D3982 Table 1 for Hand Lay-up and Spray-up or 0.20-in for round Filament Wound ductwork.

6. All laminate thicknesses for ductwork shall be calculated such that 10:1 factor of safety for internal and 5:1 for external pressure has been provided, with strain limited to 0.001 for Hand Lay-up laminates. Strain for Filament Wound laminates shall be limited to 1/10 of strain at failure, where strain at failure must be proven by Manufacturer per ASTM D638 tensile and ASTM D2584 glass content testing methods. Laminate designs used for proof of allowable strain used in calculations submitted shall be representative of same laminate sequence and resin to glass ratio as used for ductwork shown on drawings submitted.
7. Safety factors for combined loads shall be 10:1 for sustained loads and 5:1 for intermittent loads, where intermittent are combined individual loads or individual combined with sustained loads. As a minimum, loadings to be considered are defined in Paragraph 2.02(E). The greater laminate thicknesses as determined by Paragraph 2.03(D.6) and (D.7) herein shall be used.
8. The minimum longitudinal tensile strength shall be 9,000 psi for all Structural Layer laminate construction.
9. The outer most sub-layer of the Structural Layer and Outer Surface shall be pigmented and include ultra violet light inhibitor plus a 10 mil A-Glass veil containing 90 percent resin by weight.
10. The Outer Surface shall be coated with a 5 mil unreinforced resin rich layer containing paraffin wax and include pigment plus ultra violet light inhibitor.
11. Pigment color shall be submitted for approval.
12. Painting is not allowed for any FRP surface.
13. The resins specified within the laminate specifications shall be as supplied by AOC, Ashland, Interplastic or Reichhold. Only one (1) resin supplier's products are allowed for all ductwork.
14. Only Uni-axial stitched glass reinforcements are allowed where required with Filament Winding in order to meet the requirements of this Section. Reinforcing such as random strand mat stitched to woven roving shall not be permitted.
15. Vacuum infusion and other such closed or contained laminating process shall not be permitted.

#### **2.04 MANUFACTURER INSPECTION AND QUALITY CONTROL**

- A. Quality control shall include a process and a final inspection by Manufacturer. Final inspection prior to shipment shall include checks for laminate visual quality, resin cure, dimensional verification, review of certified test results for tests such as Barcol hardness, cutouts review and corrective action taken for any non-conformity reports generated.

B. Manufacturer tolerances:

1. ASTM D3982 Section 8, identified within this Paragraph for convenience:
  - a. Overall lengths are limited to plus or minus 1/4-in.
  - b. Cut ends of round ductwork shall be square within plus or minus 1/8-in for less than 24-in diameter, 3/16-in for between 24-in and 48-in and 1/4-in for greater than 48-in diameter.
  - c. Flanges:
    - 1) Face flatness plus or minus 1/32-in for less than or equal to 18-in diameter and plus or minus 1/16-in for greater than 18-in diameter.
    - 2) Warpage shall be plus or minus 3 degrees.
    - 3) Face perpendicularity to axis of duct shall be plus or minus 1/2 degree.
    - 4) Flange angularity plus or minus 1 degree for less than or equal to 24-in diameter, 3/4 degree for greater than 24-in to less than or equal to 48-in and 1/2 degree for greater than 48-in diameter.
    - 5) Offset shall be plus or minus 1/8-in.
    - 6) Cant shall be plus or minus 1/2 degree.
2. Other tolerance requirements:
  - a. Minimum thicknesses shall be minus 0.00-in plus 20% of thicknesses specified or otherwise designed per requirements of this Section.
  - b. Out of flatness is limited to the lesser of plus or minus 1/2-in or 1/2% of span.
  - c. Out of roundness is limit to the greater of plus or minus 1/8-in or 1% of ductwork inside diameter, not to exceed 3/4-in.
  - d. Angles of all fittings shall be plus or minus 1 degree, up to and including 24-inch diameter, plus or minus 3/4 degree for greater than 24-inch to less than or equal to 48-inch and plus or minus 1/2 degree for greater than 48-inch diameter.
  - e. Gap for fit-up at shop and field joint is limited to the thickness of the adjoining material, not to exceed 3/8-in, and maximum offset of lesser of 1/4-in or two (2) times edge thickness divided by three (3) prior to application of paste and butt wrap joint material.

- C. The Manufacturer shall provide adequate lead time to the Contractor, who will in turn notify the Owner, Owner's Engineer and Owner's or Engineer's designated agent at the Engineer's direction, for coordination of optional participation in major component inspection prior to assembly, test witnessing and Manufacturer's final inspection.
- D. The Engineer reserves the right to inspect and reject any and all equipment being manufactured that does not fully and completely meet the requirements of this Section. Fabrication and inspection records shall be made available upon request. The Owner, Owner's Engineer and Owner's or Engineer's designated agent will have adequate, open and safe access to the Manufacturer's facility at all times during regular business hours for purpose of inspecting equipment being manufactured for them.
- E. The Manufacturer shall make any and all inspection tools readily available to parties that may participate in inspection. Such tools shall be in a good state of repair and properly calibrated for accurate measurement. Ductwork shall be oriented for safe entry.
- F. Final acceptance by Engineer or Contractor is not in lieu of nor is it intended to compromise Manufacturer's warranty in any way as required by this Section.

## **2.05 EXTERIOR INSULATION**

- A. Insulation for FRP duct shall follow the same requirements as metallic duct. See Section 23 31 13 – Metal Ducts and Duct Accessories, Paragraph 2.05 – Duct Insulation for insulation requirements.

## **2.06 ACCESSORIES**

- A. All gaskets and fasteners required for flanges, nozzles and access points with mating parts supplied by Manufacturer shall be furnished by Manufacturer, where:
  - 1. Gasket material shall be EPDM with a shore A hardness of 60 to 70. Gaskets shall be full face, predrilled to match flange bolt pattern plus single piece construction up to 36-in diameter and dovetail vulcanized construction for sizes greater than 36-in diameter. Minimum gasket thickness shall be 1/8-in for flanges less than or equal to 6-in, 3/16-in for flanges greater than 6-in and up to 18-in and 1/4-in for flanges equal to or greater than 20-in diameter. As a minimum, rectangular ductwork gasket material specifications shall correspond to those of round ductwork having the same diameter as the longest side of the rectangular ductwork and rounded up if not equal.
  - 2. Fastener material shall be 316 stainless steel and be field coated with a corrosion resistant coating as required in the supports section of this specification. The fasteners shall be properly sized to fit gasketed or non-gasketed connections. Washers shall meet SAE or ASME B18.22.1 Type A Narrow washer seat requirements. Lock washes are not permitted.

B. Expansion joints and flexible connectors.

1. Manufacturer: Provide products of one of the following:
  - a. Holz Rubber Company Inc.
  - b. Approved Equal
2. Joints shall consist of an elastomeric reinforced flexible material with integral molded flanges. The molded flanges shall be secured to the duct or fan connections using a 3/8" metal backing plate. The backing plate and fasteners shall be field coated with a corrosion resistant coating.
3. The joint flexible material shall be Neoprene and suitable for exposure to air containing chemicals as indicated in Paragraph 2.03(B) of this specification. Alternate materials as recommended by the manufacturer shall require Engineer approval.
4. The joint body style shall be suitable for constant vacuum service.
5. The joint body thickness shall be suitable for the pressure class of the applicable ductwork. The pressure class shall be indicated in the Duct Construction Schedule at the end of this specification. The nominal body thickness shall not be less than 1/8".
6. The face to face length of the joint shall be determined by the stress and support analysis. The joint shall be able to handle the axial and lateral movements indicated in the calculations.
7. All fasteners shall be type 316 stainless steel including nuts, bolts, and washers. Lock washers shall not be used. All hardware shall be field coated with a corrosion resistant coating.

C. Manual Volume and Manual Isolation Dampers

1. Manufacturer: Provide products of one of the following:
  - a. Swartwout, Division of Phillips Industries
  - b. Belco Manufacturing
  - c. Ershigs
  - d. Approved Equal

2. All round FRP dampers shall be the butterfly type and all rectangular FRP dampers shall be of the opposed blade type. FRP fabrication shall meet the corrosion requirements specified in this Paragraph 2.03(B) of this specification
3. Fabrication:
  - a. Frame and blade: premium vinyl ester. Blade shall fully encapsulate shaft. Blades that bolt to a single side of the shaft will not be accepted.
  - b. Shaft: premium vinyl ester for all manually actuated dampers below 30 inches in diameter. The shaft shall be glassed into the damper blade with center significantly thicker than center perimeter with an even taper from center to perimeter. For all dampers 30 inches in diameter and larger, the shaft shall be type 316 stainless steel encased in FRP material. Rectangular damper shafts shall correspond to those of round ductwork having the same diameter as the side of the rectangular parallel with the blades.
  - c. Bearings and bushings: Teflon
  - d. Pins and all hardware: Type 316 stainless steel (Contractor shall field coat with corrosion resistant coating)
  - e. Shaft seals: EPDM
  - f. Provide all round dampers with a blade stop consisting of FRP angles with full circumference EPDM seals.
  - g. All dampers shall have flanged ends. Provide type 316 stainless steel bolts, nuts, and washers. (Contractor shall field coat with corrosion resistant coating)
  - h. All dampers >24" diameter shall be provided with gear operators with an epoxy coating. The coating shall be suitable for exposure to air as described in Paragraph 2.03(B) of this specification. Dampers 24" and smaller shall be supplied with hand quadrants actuators fabricated of type 316 stainless steel with a 5-stage locking quadrant indicator. All volume dampers shall have a fully adjustable slot with an extra hole drilled in the handle for the Contractor to "drill and pin-in place" once the system is balanced so the handle cannot vibrate loose. Rectangular damper shafts shall correspond to those of round ductwork having the same diameter as the side of the rectangular parallel with the blades.
  - i. All isolation dampers provided shall bear the AMCA seal. Dampers must have been tested in an AMCA lab for performance (pressure drop) and leakage. Test results shall be submitted and confirmed by the Engineer.

- j. Assembly shall be rated for flame spread less than 25 and a smoke development of less than 50 per ASTM E-84

D. Motorized Dampers:

1. Manufacturer: Provide products of one of the following:
  - a. MK Plastics Corporation
  - b. Swartwout Corporation
  - c. Polymil Products, Inc.
  - d. Approved Equal
2. Dampers shall be fiberglass with air foil blades. Damper shall be of pultruded construction and comply with ASTM-D4385-84A, ASTM E-84, and ASME/ANSI RTP1-1989. Damper blades shall be minimum of ¼ inch thick of a hollow airfoil shape and contain a slot for insertion of blade seal. Blade seal shall be silicon rubber extruded to provide a double seal. Adhesive seals are not acceptable. Bearings shall be Teflon based material.
3. Damper shall be low leakage class based on AMCA 500/511 (3 cfm/sq.ft maximum leakage rate at 1 inch w.c.)
4. Dampers shall bear the AMCA seal.
5. Material used in construction shall be a flame retardant vinyl ester based resin.
6. All materials used shall be corrosion resistant and appropriate for exposure to air containing chemicals as indicated in Paragraph 2.03(B) of this specification. All hardware and miscellaneous parts that are not FRP shall be type 316 stainless steel. Any non-fiberglass fasteners located in the air stream shall be fully encapsulated in the FRP material. The Contractor shall field coat all non-encapsulated metallic components with a corrosion resistant coating.
7. Actuators shall be externally mounted to the damper and shall be a minimum of NEMA 2. All actuators shall be enclosed in a NEMA 4X enclosure unless otherwise specified. Actuators located in classified spaces shall be enclosed in a NEMA 7 case unless otherwise specified. See Section 23 31 13 – Metal Ducts and Duct Accessories for additional actuator requirements.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Caution should be exercised when placing ductwork, with special attention paid to nozzles and other such projections that interface with adjacent area or could get entangled and damaged during handling.
- B. All FRP butt wrap work must be done at temperatures between 60 and 90 degrees Fahrenheit and humidity less than 80%, without exposure to wind, rain, snow, direct sunlight and any other wet and extreme temperature conditions beyond these ranges permitted. Temporary weather tight temperature and humidity controlled shelters shall be provided by Contractor where needed during field butt wrap joining procedures.
- C. Ductwork shall be stabilized and isolated from any and all movement during FRP butt and wrap field joint work.
- D. Hazardous materials, fiberglass dust, and styrene emissions propagated through cutting, grinding and laminating operations shall be managed per procedures provided.
- E. Turning Vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum amount of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation.
- F. The dial regulators for manual dampers shall be marked so that the “open” and “shut” positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that fasteners do not protrude into the duct and interfere with damper operation.
- G. Access doors shall be provided at all apparatus requiring service or inspection in the duct system.
- H. Test openings shall be installed in the ductwork at the points listed below. The openings shall be sealed by a screw cap and gasket and shall be installed so that the insulation is not disturbed when the cap is removed. The test openings shall be located as follows in all heating, ventilating, air conditioning, and dehumidification systems:
  - 1. Upstream and downstream of each coil
  - 2. In the outside air duct adjacent to HVAC equipment
  - 3. In the return air duct adjacent to HVAC equipment



- 4. In the main supply duct on single zone units and in each zone supply duct on multizone units
  - 5. Upstream and downstream of each filter bank
  - 6. Where indicated on Design Drawings
- I. See Section 23 31 13 – Metal Ducts and Duct Accessories, Section 3.03 – Insulation Installation for insulation installation location requirements.

**3.02 FIELD INSPECTION AND PERFORMANCE TESTING**

- A. Contractor shall inspect ductwork for conformance to laminate quality, thicknesses, major dimensions and tolerances per this Section upon receipt and notify Engineer in writing of nonconformities that will inhibit timely completion of installation. Unless otherwise acknowledged by Engineer in writing, Contractor shall not proceed until nonconformities are corrected by Manufacturer.
- B. Contractor shall perform a process installation inspection, with required reporting per Paragraph 1.05 G.
- C. Manufacturer’s Field Services:
  - 1. Provide qualified Manufacturer’s Technical Representative to perform FRP butt wrap training for Contractor ductwork installers. Manufacturer’s Technical Representative shall provide a minimum of one (1) day training or one (1) day per ten (10) field FRP butt wrap joints, whichever is more, but not to exceed five (5) days of training. Training shall be consecutive days.
  - 2. The manufacturer Technical Representative’s field services shall include the following site visits for installation in accordance with Section 01 75 00 – Checkout and Startup Procedures:

Service	Total Days	No. of Trips	Remarks
Installation Checkout	1	1	In accordance with Section 01 75 00 – Checkout and Startup Procedures

- 3. Manufacturer’s obligation under substantial completion is satisfied with, Manufacturer’s submittal of Certificate of Proper Installation per Paragraph 1.05.
- D. Ductwork system shall be free from deflection, pulsation, vibration, chatter, leakage or any other such condition when system is in or out of service.
- E. See Section 23 05 95 – HVAC Testing for additional testing and balancing requirements.

**3.03 CLEANING**

- A. Ductwork shall be thoroughly cleaned inside and out by Contractor prior to being put into service.
- B. All temporary labeling used to identify piece numbers for installation shall be removed where not a part of permanent labeling.
- C. Ductwork cleaning process shall use materials that will not harm ductwork, be performed after ductwork installation and before Manufacturer’s field inspection services required per this Section.

**Duct Construction Schedule**

<b>Service</b>	<b>Pressure Class</b>	<b>Leakage Class</b>	<b>Duct Material</b>
Dewatering Exhaust	+/- 4 inwg.	12	FRP

**END OF SECTION**

**23 SECTION 23 34 00****HVAC FANS****PART 1 – GENERAL****1.01 GENERAL REQUIREMENTS**

- A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.
- B. All anchor bolts, washers, clips, clamps and fasteners of any type shall be constructed of 316 stainless steel.
- C. All fan motors shall be provided with high premium energy efficient totally enclosed fan cooled type, unless otherwise noted.
- D. Provide exhaust fans which have been tested and rated in accordance with AMCA standard, and bear AMCA Certified Ratings Seal.
- E. Provide motors and electrical accessories complying with NEMA standards.
- F. Fans shall be standard prefabricated units of the type, size and arrangement indicated on the Drawings. All fans shall be rated and constructed in accordance with the Air Moving and Conditioning Association. Special construction materials, coatings and multi-speed fan motors shall be provided as indicated on the Drawings.
- G. Impellers shall be rigidly constructed, accurately balanced dynamically and statically at the speed at which it is scheduled to operate and free from objectionable vibration or noise. Fans with corrosion resistant coatings shall be balanced after being coated.
- H. Fans shall have no overloading characteristics for the horsepower indicated. All points on the fan brake horsepower curve shall not exceed the motor horsepower rating
- I. Fan shall have a Fan Efficiency Index equal to or greater than 1.0
- J. V-belt drives shall be rated at least 50 percent greater than the rated motor horsepower, and shall have sheaves which can vary the fan speed by 10 percent above or below the rating point. The fan motor shall be mounted on an adjustable heavy mounting plate.

- K. The operating fan speed shall be no greater than 85% of the maximum allowable fan speed for the selected model.
- L. Unless otherwise noted on the Fan Schedule fans shall be manufactured to meet the balance quality and vibration limits of Fan Application Category BV-3 per AMCA Standard 204.

### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01 73 23 – Seismic Anchorage and Bracing
- B. Section 23 05 48 – Vibration and Seismic Controls for HVAC
- C. Section 23 00 00 – Basic HVAC Requirements
- D. Section 23 080 00 – Commissioning of HVAC Systems
- E. Section 23 31 13 – Metal Ducts and Duct Accessories
- F. Section 23 31 16 – Nonmetal Ducts and Duct Accessories
- G. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

### **1.03 SUBMITTALS**

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this Section in accordance with Section 01 33 00 – Submittal Procedures.
- B. The Contractor shall submit shop drawings for fan supports, locating and identifying each support, brace, hanger, guide, component and anchor. Fan support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer of the State or Commonwealth in which the project is located and shall comply Section 01 73 23 – Seismic Anchorage and Bracing and Section 23 05 48 – Vibration and Seismic Controls for HVAC.
- C. Required information shall include:
  - 1. Horsepower, voltage, and rotating speed of motors.
  - 2. Total weight of the equipment plus the approximate weight of the shipped materials.
  - 3. Complete erection, installation, and adjustment instructions and recommendations.

4. Fan performance curve at the operating speed, minimum, and maximum speeds. Provide brake horsepower curve for the operating speed.
  5. Details of corrosion resistance coating.
  6. Detailed construction information and data sheets for all accessories such as roof curbs, dampers, damper operators disconnect switches, vibration isolators etc.
  7. Example equipment nameplate data sheet.
  8. Interconnecting wiring diagrams.
  9. List of recommended lubricants.
  10. Special Tools List
  11. Reports of Certified Shop Tests
  12. AMCA Approval for Fan Ratings
  13. Sound data
  14. Manufacturer's Installation Certification
  15. Manufacturer's Field Test Results Certification
- D. The Contractor shall submit to the Owner a color chart of available colors for the corrosion coating to be applied to fans as indicated in the Contract Documents. The Owner shall select the final color choice.

#### **1.04 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures.

#### **1.05 MANUFACTURERS**

- A. The materials covered by these specifications are intended to be equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

**1.06 CONTRACTOR'S RESPONSIBILITY AND MANUFACTURER'S FIELD SERVICES**

- A. The services of a qualified manufacturer's Technical Representative shall be provided. The manufacturer Technical Representative's services shall include the following site visits:

Service	Total Days	No. of Trips	Remarks
Installation Checkout	1	1	In accordance with Section 23 34 00 – HVAC Fans
Startup and Testing	3	3	In accordance with Section 23 05 93 – Testing, Adjusting and Balancing and Section 23 08 00 – Commissioning of HVAC System
Training	1	1	In accordance with Section 07 79 00 – Instruction of Owner's Personnel

- B. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.
- C. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

**1.07 SPECIAL TOOLS**

- A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

**PART 2 – PRODUCT**

**2.01 MIXED FLOW INLINE FANS**

- A. Mixed flow fans shall be non-overloading single thickness blades of aluminum construction. The blades shall be continuously welded to the backplate. Wheel inlets shall overlap an aerodynamic aluminum inlet cone.
- B. Wheel shall be balanced in accordance with AMCA Standard 204-05.
- C. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- D. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.

- E. Motors on V-belt units shall be supported on the exterior of the fan casing with bearings encased within the fan tube. Motors shall be protected and cooled from outside the unit by forced ventilation.
- F. Fan shall be supported from a structural base with integral vibration isolation provisions.
- G. Fans shall have internal terminal box mounted on the exterior for ready wiring.
- H. The motor shall be separated from the air stream.
- I. Adjustable motor plates shall utilize threaded rods to provide positive belt tensioning.
- J. Extended lube lines shall be furnished for lubrication of the fan bearings.
- K. Bearings shall be heavy duty regreasable ball type in a pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- L. Belts shall be oil and heat resistant, static conducting.
- M. Drives shall be keyed and securely attached to the wheel and motor shafts.
- N. All drives shall be variable pitched for 10 hp and less and fixed pitched for fans greater than 10 HP.
- O. The fan drives shall be sized for 150 percent of the installed motor horsepower.
- P. Mixed flow fans shall be as manufactured by Loren Cook Co., Greenheck Fan Corp., Hartzell, or approved equal.
- Q. See Paragraph 2.06 of this specification for additional requirements.

## **2.02 INLINE CENTRIFUGAL FANS**

- A. Centrifugal fans shall be backwardly inclined, non-overloading. Wheel inlets shall overlap an aerodynamic inlet cone.
- B. The fan shall be of 316 stainless steel construction unless otherwise noted.
- C. The fan shall be rated AMCA Type A or B spark resistant construction where required by the Contract Drawings.
- D. Wheel shall be balanced in accordance with AMCA Standard 204-05.
- E. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- F. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.

- G. Motors on V-belt units shall be supported on the exterior of the fan casing with bearings encased within the fan tube. Motors shall be protected and cooled from outside the unit by forced ventilation.
- H. Fan shall be supported from a structural base with integral spring vibration isolators.
- I. Fans shall have internal terminal box mounted on the exterior for ready wiring.
- J. Housing shall be supplied with a bolted and gasketed access door.
- K. The motor shall be separated from the air stream.
- L. Adjustable motor plates shall utilize threaded rods to provide positive belt tensioning.
- M. Extended lube lines shall be furnished for lubrication of the fan bearings.
- N. Bearings shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L10 life of 50,000 hours at maximum catalogued operating speed.
- O. Belts shall be oil and heat resistant, static conducting.
- P. Drives shall be keyed and securely attached to the wheel and motor shafts.
- Q. All drives shall be variable pitched for 10 hp and less and fixed pitched for fans greater than 10 HP.
- R. The fan drives shall be sized for 150 percent of the installed motor horsepower.
- S. Mixed flow fans shall be as manufactured by Hartzell, Loren Cook Co., Greenheck Fan Corp., Hartzell, or approved equal.
- T. See Paragraph 2.06 of this specification for additional requirements.

### **2.03 ROOF MOUNTED UPBLAST CENTRIFUGAL EXHAUST FANS**

- A. Centrifugal fans shall be backwardly inclined, non-overloading blades of aluminum construction. Wheel inlets shall overlap an aerodynamic aluminum inlet cone.
- B. Wheel shall be balanced in accordance with AMCA Standard 204-05.
- C. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- D. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.



- E. The aluminum base shall have a one-piece inlet spinning and continuously welded curb cap corners.
- F. The two-piece top cap shall have stainless steel quick release latches to provide access to the motor compartment without the use of tools.
- G. Fans shall have internal terminal box mounted on the exterior for ready wiring.
- H. The motor shall be separated from the exhaust air stream.
- I. Bearings shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- J. Belts shall be oil and heat resistant, static conducting.
- K. Drives shall be keyed and securely attached to the wheel and motor shafts.
- L. All drives shall be variable pitched for 10 hp and less and fixed pitched for fans greater than 10 HP.
- M. The fan drives shall be sized for 150 percent of the installed motor horsepower.
- N. Centrifugal fans shall be as manufactured by Loren Cook Co., Greenheck Fan Corp, or approved equal.
- O. See Paragraph 2.06 of this specification for additional requirements.

#### **2.04 WALL MOUNTED PROPELLER FANS**

- A. Fans shall be an airfoil propeller fan with integral wall panel. The power assembly shall be bolted to a heavy-duty wall panel with continuously welded corners and an integral venturi. The fan and wall panel shall be all aluminum construction.
- B. The propeller shall be extruded aluminum air foil design with cast aluminum hub. The hub shall be keyed and locked to the shaft utilizing two set screws or a taper lock bushing.
- C. Propeller shall be balanced in accordance with AMCA Standard 204-05.
- D. Provide fans which are listed by UL and have a UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- E. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.

- F. The motor, bearings, and drives shall be mounted on a heavy-duty aluminum power assembly.
- G. Fans shall have internal terminal box mounted on the exterior for ready wiring.
- H. Adjustable motor plates shall utilize threaded rods to provide positive belt tensioning.
- I. Bearings shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L10 life in excess of 50,000 hours at maximum catalogued operating speed.
- J. Belts shall be oil and heat resistant, static conducting.
- K. Drives shall be keyed and securely attached to the wheel and motor shafts.
- L. All drives shall be variable pitched for 10 hp and less and fixed pitched for fans greater than 10 hp.
- M. The fan drives shall be sized for 150 percent of the installed motor horsepower.
- N. Provide OSHA motor guard to prevent accidental contact with motor or fan blades. The guard shall be of aluminum construction.
- O. Provide aluminum wall sleeve.
- P. Centrifugal fans shall be as manufactured by Hartzell, Greenheck Fan Corp., Loren Cook Co, or Approved Equal.
- Q. See Paragraph 2.06 of this specification for additional requirements.

## **2.05 FIBERGLASS REINFORCED PLASTIC (FRP) CENTRIFUGAL UPBLAST FANS**

- A. Product and Manufacturer: Provide product(s) of one of the following:
  - 1. MK Plastics Model RBK
  - 2. Approved Equal
- B. General:
  - 1. Provide fans that are factory-fabricated and assembled, factory-tested, and factory-finished, with indicated capacities and characteristics. All air side materials shall be suitable to convey chemically laden odorous air typically found in and around wastewater treatment facilities. Chemicals present include up to 200 ppm Sulfuric Acid, 5 ppm Hydrogen Sulfide, 10 ppm Sodium Hypochlorite, and 10 ppm

Sodium Hydroxide. These odorous compounds in the air conveyed may reach as high as 100 percent relative humidity.

2. Base fan performance at standard conditions (density 0.075 lb/ft<sup>3</sup>).
  3. Selected fans are to be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
  4. Fans are to be belt driven unless indicated otherwise on the equipment schedule.
  5. Fans are to be equipped with lifting lugs.
  6. Nameplate: Each fan to be furnished with a permanently affixed SS nameplate with manufacturer's name, model number, serial number and electrical data.
  7. Rotating Assembly: Statically and dynamically balanced to balance grade G6.3 per ANSI/AMCA 204-96 and designed for continuous operation at the maximum rated fan speed and motor horsepower.
- C. Provide fiberglass reinforced plastic (FRP) fire retardant fans with a flame spread rating of 25 or less when tested per ASTM-E84. Fans shall be installed complete with motors, drives, guards, and coatings of sufficient capacity for the duty required.
- D. Fan shall be constructed such that all surfaces in contact with the corrosive gas stream are made of solid, corrosion resistant FRP. No metal parts shall be in contact with the air stream.
- E. A veil coating with electrical grounding shall be provided.
- F. Performance: Fan ratings shall be based on tests made in accordance with AMCA Standard 210. Fans shall be licensed to bear the AMCA Certified Ratings Seal for Air Performance. Fans not licensed to bear the AMCA Seal for performance shall be tested, at supplier's expense, in an AMCA Registered Laboratory. Fans shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation. Fan speed and motor size shall be selected by the manufacturer to meet the required conditions of air flowrate and pressure drop specified above. Fan speed shall not exceed 85% of the maximum allowable driven speed of the fan.
- G. Sound: Fan manufacturers shall provide sound power level ratings for fans tested and rated in accordance with AMCA Standards 300 and 301. Sound power ratings shall be in decibels (reference IOE-12 watts) in eight octave bands.
- H. Construction: Fan shall be constructed in accordance with the ASTM D-4167 standard specification for fiber-reinforced plastic fans and blowers to ensure structural integrity. All surfaces exposed to the atmosphere shall be resin rich of a paraffinated resin stabilized against ultraviolet degradation and include a reinforcement not to exceed 20% "C" grade

fiberglass. All parts exposed to the gas stream shall be constructed of, or encapsulated in, an FRP laminate capable of resisting continuous airstream temperatures of 210 degrees Fahrenheit. Use of pigments, gel coats, inhibitors and additives which may disguise flaws in the laminate is prohibited. Other minimum construction requirements shall consist of the following:

1. Housing - Fan housing shall be constructed of a fire retardant vinyl ester (Derakane 510A or equal) resin with an ASTM E84 Class I rating. Housing laminate construction shall conform to ASTM Standard C-582. Airstream surfaces shall be smooth to minimize resistance and prevent buildup of airborne contaminants. Fan shall be furnished with a lubricatable, double-lip Teflon shaft seal. The housing shall be impregnated with graphite to allow grounding of the housing to dissipate static electricity and shall have a grounding connection on the outside of the fan. The housing shall contain a drain to permit the drainage of rainwater.
  2. Wheel - Wheel shall be fabricated of a fire-retardant vinyl ester resin with an ASTM E84 Class II rating no greater than 30. Wheel hub shall be keyed to the shaft. Steel wheels coated with FRP are not acceptable.
  3. Shaft - Shaft shall be 316 stainless steel and shall not be exposed to the air stream. The shaft first critical speed shall be at least 125 percent of the fan's maximum operating speed.
- I. Fan wheel shall have single thickness air foil type blades or backwardly inclined blades and shall not exceed the brake horsepower shown on the schedule.
  - J. Balance and Run Test: The wheel and shaft shall be dynamically balanced as an assembly to a balance quality grade of G6.3 at the factory. The test procedure shall be sent to the Engineer for approval and the final results shall be sent for record. Prior to shipment, completed fans shall receive a final test balance at the specified operating speed.
  - K. Final Inspection: All fans shall receive a final inspection by a qualified inspector prior to shipment. Inspection shall include: fan description and accessories, balance, welding, dimension, bearings, duct and base connection points, paint finish and overall workmanship.
  - L. The Contractor shall properly ground the fan case to dissipate static electricity.
  - M. Fan Motors and Drive:
    1. Shafts: Precision turned, ground and polished 316 stainless steel sized so that the first critical speed is at least 25 percent over the maximum operating speed.

2. Bearings:
  - a. Type: Air Handling Quality, heavy-duty, grease lubricated, self-aligning ball or roller pillow block type. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block.
  - b. Fixed to the fan shaft using concentric mounting locking collars. Bearings that use set screws are not acceptable.
  - c. Minimum (L10) life in excess of 80,000 hours at maximum cataloged operating speeds. Life as specified in accordance with ABMA Standard 9 for ball bearings and ABMA Standard 11 for roller bearings. Bearing life is not to be reduced below specified level if fan mounting or motor orientation is changed.
  - d. Provide extended lube lines with Zerk fittings.
  - e. Bearings enclosed within the fan housing where they can be exposed to the corrosive gas stream are not acceptable.
3. Belt or Direct Drives:
  - a. Drive components to be sized based on a service factor of 1.4.
  - b. Pulleys for belt drives shall be of the fully machined stainless steel type, keyed and securely attached to the wheel and motor shafts. Motor pulleys to be adjustable for final balancing.
  - c. Belts: Oil-resistant, non-sparking, and non-static.
  - d. Belt drives are to be factory-mounted, with final alignment and belt adjustment made after installation.
  - e. Guards: Provide FRP, corrosion resistant, OSHA compliant belt guards and motor guards. The Guards shall completely cover any exposed moving or rotating parts.
4. Motors:
  - a. Motor construction shall be as indicated on the Design Drawings and meet requirements of applicable motor sections in Division 26.
  - b. Motor Sizes: Minimum sizes and electrical characteristics as indicated on the Design Drawings. The motor shall be large enough so that the driven load

will not require the motor to operate in the service factor range at any point along the fan curve at the design speed.

- c. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.
- d. Provide motor with an adjustable base for varying belt tension and belt alignment for belt driven fans.
- e. Where fans are indicated to require VFDs, the motors shall be rated for operation with a VFD.

N. See Paragraph 2.06 of this specification for additional requirements.

## **2.06 ADDITIONAL REQUIREMENTS FOR ALL FANS**

A. The following additional requirements shall apply to all fans.

1. Backdraft or motor-operated dampers shall be provided and installed in the openings as indicated on the Contract Drawings.
2. All fans shall be provided with either integral or supplementary spring vibration or sound-absorbing mountings.
3. Fans that are curb mounted be provided with vibration isolation type curb (and seismic/wind rating as required).
4. Where indicated, roof mounted exhaust fans shall be mounted on a prefabricated roof curb.
5. All motors unless indicated otherwise in this Specification or the Contract Drawings shall be TEFC. The brake horsepower at any point on the fan curve for the design speed shall not exceed the motor nameplate horsepower. The brake horse power shall include all applicable belt drive losses. Using the motor service factor shall be prohibited.
6. All equipment shall be seismically secured and restrained in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, latest edition, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) and designed in accordance with the seismic provisions of ASCE-7 and the current Building Code of the State or Commonwealth in which the project is located to the extent that the most stringent provisions are utilized in developing the design seismic forces. See Section 01 73 23 – Seismic Anchorage and Bracing and Section 23 05 48 – Vibration and Seismic Controls for HVAC for additional details and requirements.

7. All non-fiberglass fans shall receive a corrosion resistant coating. The coating shall be an epoxy coating suitable for protecting the equipment from continuous exposure to air containing hydrogen sulfide 3ppm. The coating shall be applied to all surfaces of the fans including but not limited to fan wheels, propellers, hubs, structural components, housings (interior and exterior), inlet boxes, dampers, screens, lube lines, curb boxes, and curb box adapters. A UV resistant top coat shall be applied to all coating systems that are not rated for UV exposure. The Contractor shall submit and coordinate the available color choices to the Owner for final color selection.
8. Where indicated in the design documents, fans shall exceed the uncertainty requirements of AMCA standard 203 and shall perform within +/- 3% of the flowrate with respect to the static pressure of the fan curve.

## **2.07 DAMPERS**

- A. See the respective paragraphs in Section 23 31 13 – Metal Ducts and Duct Accessories and Section 23 31 16 – Nonmetal Ducts and Duct Accessories for construction requirements.
- B. Dampers shall be coordinated to operate and interface with the fan being furnished.
- C. Dampers shall be sized to fit the specified openings.

## **2.08 PREFABRICATED ROOF AND WALL CURBS**

- A. Prefabricated roof and wall curbs shall be installed where indicated on the Drawings or as specified herein. The curbs shall be fabricated of .064 inch sheet aluminum with all joints heliarc welded. Cants and roof flanges shall be an integral part of the curb. The inside of the curb shall be insulated with rigid glass-fiber thermal and acoustical liner of approximately 3-lb. density and 1-1/2 inch minimum thickness with a neoprene or equal coating for protection from erosion. The lining shall conform to NFPA 90A Standards with a flame spread and fuel contributed rating not exceeding 50. Pressure-treated wood nailers shall be provided at the tops of the curbs. The curbs shall be sized to suit equipment. Roof curbs shall be a nominal of 12-inches above the height of the roof unless indicated otherwise on the Contract Drawings. The roof curbs shall receive an epoxy corrosion resistant coating on the interior and exterior surfaces that is suitable for the conditions indicated in the Additional Requirements for All Fans section above.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Contractor shall install fans in accordance with manufacturer's installation instructions and recognized industry practices to ensure that ventilators serve their intended function.

- B. Contractor shall coordinate fan work with work of walls, and ceilings, as necessary for proper interfacing.
- C. Connect ducts to fans in accordance with manufacturer's installation instructions.
- D. The Contractor shall have the Manufacturer's Technical Representative provide in writing that the equipment is installed per the manufacturer's requirements and operates as required by the Contract. The Contractor shall submit the written confirmation to the Engineer for information only.

### **3.02 FIELD QUALITY CONTROL**

- A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements as specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. See Section 23 05 95 – HVAC Testing for testing requirements.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched coatings with a coating specified by the equipment manufacturer for repairs.

**END OF SECTION**



**SECTION 23 40 00**  
**HVAC AIR CLEANING DEVICES**

**PART 1 – GENERAL**

**1.01 DESCRIPTION**

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE Standard 52.2 for definitions of face velocity, net effective filtering area, media velocity, initial resistance (pressure drop), MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency), particle size ranges for each MERV number, dust holding capacity and explanation of electrostatic media used filtration products versus mechanical filtration products. Refer to ASHRAE Standard 52.2 Appendix J for definition of MERV-A.

**1.02 RELATED WORK**

- A. Section 00 72 00, GENERAL CONDITIONS
- B. Section 01 33 00, SUBMITTAL PROCEDURES.
- C. Section 23 05 00, BASIC HVAC REQUIREMENTS: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- E. Section 23 37 00, AIR OUTLETS AND INLETS.
- F. Section 23 75 00, CUSTOM AIR-HANDLING UNITS: Filter housing and racks.

**1.03 QUALITY ASSURANCE**

- A. Air Filter Performance Report for Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standard 52.2 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. Filters utilizing partial or complete synthetic media will be tested in compliance with pre-conditioning steps as stated in Appendix J. All testing is to be conducted on filters with a nominal 24 inch by 24 inch face dimension. Test for 150 m/min (500 fpm) will be accepted for lower

velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification

- B. Filter Warranty for Extended Surface Filters: Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no cost to the Owner.
- C. Comply with UL Standard 900 for flame test.
- D. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency.

**1.04 SUBMITTALS**

- A. Submit in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.
- B. Manufacturer's Literature and Data:
  - 1. Extended surface filters.
  - 2. Holding frames. Identify locations.
  - 3. Side access housings. Identify locations, verify insulated doors.
  - 4. Magnehelic gages.
- C. Air Filter performance reports.
- D. Suppliers warranty.

**1.05 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):  
52.2-2017.....Method of Testing General Ventilation Air-Cleaning Devices for  
Removal Efficiency by Particle Size, including Appendix J
- C. American Society of Mechanical Engineers (ASME):  
NQA-1-2022 .....Quality Assurance Requirements for Nuclear Facilities  
Applications
- D. Underwriters Laboratories, Inc. (UL):

900; Edition 8 2022.....Test Performance of Air Filter Units

**PART 2 – PRODUCTS**

**2.01 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED**

- A. To allow temporary use of HVAC systems for testing provide one complete set of additional filters to the Resident Engineer Ace Mountings Co., Inc.
- B. The Owner’s Representative will direct whether these additional filters will either be installed as replacements for dirty units or turned over to Owner for future use as replacements.

**2.02 EXTENDED SURFACE AIR FILTERS**

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the contaminant load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL listed and approved conforming to UL Standard 900.
- C. HVAC Filter Types

HVAC Filter Types Table 2.2C				
MERV Value ASHRAE 52.2	MERV-A Value ASHRAE 62.2 Appendix J	Application	Particle Size	Thickness /Type
8	8-A	Pre-Filter	3 to 10 Microns	50 mm (2-inch) Throwaway
11	11-A	After-Filter	1 to 3 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid Cartridge
13	13-A	After-Filter	0.3 to 1 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid Cartridge
14	14-A	After-Filter	0.3 to 1 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid Cartridge

**2.03 MEDIUM EFFICIENCY PLEATED PANEL PRE-FILTERS (2” ; MERV 8; UL 900 CLASS 2):**

- A. Construction: Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic or 100% virgin synthetic media, self supporting media with required media stabilizers, and beverage board enclosing frame. Filter media shall be lofted to a uniform depth and formed into a uniform radial pleat. The media stabilizers shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.
  
- B. Performance: The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2. It shall also have a MERV-A of 8 when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-2014 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24” x 24” face dimension.

Minimum Efficiency Reporting (MERV)	8
Dust Holding Capacity (Grams)	105
Nominal Size (Width x Height x Depth)	24x24x2
Rated Air Flow Capacity (Cubic Feet per Minute)	2,000
Rated Air Flow Rate (Feet per Minute)	500
Final Resistance (Inches w.g.)	1.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.66
Rated Initial Resistance (Inches w.g.)	0.33

- C. The filters shall be approved and listed by Underwriters’ Laboratories, Inc. as Class 2 when tested according to U.L. Standard 900 and CAN 4-5111.

## 2.04 FILTER HOUSINGS/SUPPORT FRAMES

### A. Side Servicing Housings (HVAC Grade)

1. Filter housing shall be two-stage filter system consisting of 16-gauge galvanized steel enclosure, aluminum filter mounting track, universal filter holding frame, insulated dual-access doors, static pressure tap, filter gaskets and seals. In-line housing depth shall not exceed 21". Sizes shall be as noted on enclosed drawings or other supporting materials
2. Construction: The housing shall be constructed of 16-gauge galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components. Corner posts of Z-channel construction shall ensure dimensional adherence. //Where installed outdoors, the housing shall be weatherproof and suitable for rooftop/outdoor installation.// The housing shall incorporate the capability of two stages of filtration without modification to the housing. A filter track, of aluminum construction shall be an integral component of housing construction. The track shall accommodate a 2" deep prefilter, a 6" or 12" deep rigid final filter, or a pocket filter with header. Insulated dual access doors, swing-open type, shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges. A universal holding frame constructed of 18-gauge galvanized steel, equipped with centering dimples, multiple fastener lances, and polyurethane filter sealing gasket, shall be included to facilitate installation of high-efficiency filters. The housing shall include a pneumatic fitting to allow the installation of a static pressure gauge to evaluate pressure drop across a single filter or any combination of installed filters.
3. Performance: Leakage at rated airflow, upstream to downstream of filter, holding frame, and slide mechanism shall be less than 1% at 3.0" w.g. Leakage in to or out of the housing shall be less than one half of 1% at 3.0" w.g. Accuracy of pneumatic pressure fitting, when to evaluate a single-stage, or multiple filter stages, shall be accurate within  $\pm 3\%$  at 0.6" w.g.
4. Manufacturer shall provide evidence of facility certification to ISO 9001:2015.

## 2.05 INSTRUMENTATION

- A. Magnehelic Differential Pressure Filter Gages: Nominal four inch diameter, zero to zero to two inch water gage, Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.
- B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 00 HVAC AUTOMATIC TEMPERATURE CONTROLS

- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.
- D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

## **2.06 HVAC EQUIPMENT FACTORY FILTERS**

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are not permitted.
- C. Automatic Roll Type filters are not permitted.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Install supports, filters and gages in accordance with manufacturer's instructions.

### **3.02 START UP AND TEMPORARY USE**

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.
- B. Replace Pre-filters and install clean filter units prior to final inspection as directed by the Resident Engineer.

### **3.03 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**END OF SECTION**

**SECTION 23 51 23  
FLUE GAS VENTS**

**PART 1 – GENERAL**

**1.01 SCOPE OF WORK**

- A. Provide flue gas vents as required, scheduled and specified herein.

**1.02 DESIGN REQUIREMENTS**

- A. Design requirements are based on Part 2 specified requirements of products.
- B. For boiler venting, coordinate with boiler requirements of Sections 23 51 00.

**1.03 RELATED WORKS**

- A. Section 23 00 00 – Basic HVAC Requirements.
- B. Section 20 08 00 –Commissioning. Of HVAC System.

**1.04 REFERENCE STANDARDS**

- A. Standards and codes to be latest editions adopted by and enforced by local governing authorities.
- B. CAN/CSA B149.1 Natural Gas and Propane Installation Code.
- C. CAN/ULC S604 Standard for Factory-Built Type "A" Chimney.
- D. CAN/ULC S605 Gas Vents.
- E. CAN/ULC-S609 Low Temperature Vents-Type L.

**1.05 TRAINING**

- A. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- B. Include for 3 training sessions of maximum 7 hours duration per session for 7 Metrolinx people per session.
- C. Refer to Section 23 00 00 for additional general requirements.

**1.06 WARRANTY**

- A. Products to be guaranteed by manufacturer, for a minimum of 2 years after acceptance by Metrolinx.

**1.07 DELIVERY, STORAGE AND HANDLING**

- A. Handle and store products in accordance with manufacturer's instructions, in locations approved by Metrolinx. Include one copy of these instructions with product at time of shipment.

**1.08 SUBMITTALS**

- A. Refer to submittal requirements in Section 20 05 05.
- B. Supply a reviewed shop drawing to appropriate trade to indicate vent size and flashing materials supplied, and accurately locate building openings.
- C. Submit shop drawings/product data sheets as follows:
  - 1. to regulatory authority for review and approval prior to submitting to Consultant.
  - 2. for all products specified in this Section.
- D. Product Data:
  - 1. Submit product data sheets indicating:
    - a. technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;
    - b. performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol;
    - c. product transportation, storage, handling, and installation requirements;
    - d. product identification in accordance with Metrolinx requirements.
- E. Shop Drawings:
  - 1. Submit shop drawings indicating:
    - a. capacity and ratings;
    - b. mounting details to suit locations shown, indicating methods and hardware to be used.



## 1.09 QUALITY ASSURANCE

### A. Manufacturers Qualifications

1. Manufacturer shall be ISO 9000, 9001 or 9002 certified. Manufacturer of product shall have produced similar product for a minimum period of five years. When requested by Consultant, an acceptable list of installations with similar product shall be provided demonstrating compliance with this requirement.
2. Where manufacturers provide after installation onsite inspection of product installations, include for manufacturer's authorized representative to perform onsite inspection and certificate of approvals.

### B. Installers Qualifications

1. Installers for work to be performed by or work under licensed Mechanical Contractor.
2. Installers of equipment, systems and associated work are to be fully qualified and experienced installers of respective products and work in which they are installing.
3. Where manufacturers provide training sessions to installers and certificates upon successful completion, installers to have obtained such certificates and submit copies with shop drawings.

### C. Regulatory Requirements

1. Products and work to comply with applicable local governing authority regulations, bylaws and directives.
2. Include for required inspections and certificate of approvals of installation work from local governing authorities.

## PART 2 – PRODUCTS

### 2.01 DOUBLE WALL TYPE "A" VENT

- A. Sectional, prefabricated, double wall, type 316 stainless steel, insulated Type "A" all fuel vent, ULC listed and labelled to CAN/ULC S604, Standard for Factory-Built Type "A" Chimney, maximum 540°C (1000°F) rated, with prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter- flashing piece, and a termination cap.

**2.02 DOUBLE WALL TYPE "B" VENT**

- A. Sectional, prefabricated, double wall Type "B" gas vent, ULC listed and Labelled to CAN/ULC S605, Gas Vents, maximum 243°C (460°F) rated, with an aluminium alloy inner wall, G90 galvanized steel outer wall, annular air space, prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

**2.03 DOUBLE WALL STAINLESS STEEL VENT FOR CONDENSING EQUIPMENT**

- A. Positive pressure double wall stainless steel flue gas vent with a type 304 outer casing, an AL29-4C inner flue, and a 25 mm (1") annular air space, ULC S636 listed and labelled, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

**2.04 DOUBLE WALL TYPE "L" VENT**

- A. Type "L" Neutral or negative pressure Type "L" double wall stainless steel flue gas vent, listed and labelled to CAN/ULC-S609, Low Temperature Vents-Type L, with a type 304 stainless steel outer casing, type 304 stainless steel inner flue, and a 12 mm (½") annular air space, maximum 300°C (570°F) rated, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

**2.05 BAROMETRIC DAMPERS**

- A. Field Controls or approved equivalent, UL/ULC listed and CSA certified Type M+MG2, field adjustable, single or double acting barometric damper to suit burner fuel, each complete with a gate which rests on a long, thin, stainless steel knife edge which in turn is supported by self-aligning and self-cleaning bearings, sized to suit the application, approved by equipment manufacturer, and complete with a field thermal switch accessory for dual fuel oil/gas fired burners.

**PART 3 – EXECUTION****3.01 INSTALLATION OF CONDENSING EQUIPMENT GAS VENTS**

- A. Provide double wall stainless steel type flue gas vents and combustion air intakes for condensing appliances.
- B. Support spacing is to be in accordance with flue gas vent manufacturer's instructions. Installation is to be in accordance with gas fired appliance manufacturer's instructions and requirements of CAN/CSA B149.1.

- C. Route piping using shortest route possible to termination point while avoiding interference with other work. Slope vent piping for positive drainage.
- D. Equip termination of vent with a turn-down elbow with open end covered with bronze insect screen. Terminate exhaust vent a minimum of 3 m (10') away from fresh air intakes and operable windows.
- E. Confirm flue gas vent diameter prior to ordering.

### **3.02 INSTALLATION OF GLUE GAS VENTS**

- A. Provide ULC listed and labelled flue gas vents for equipment. Confirm flue gas vent diameters prior to ordering.
- B. Secure horizontal sections in place by means of support hardware supplied with vents and conforming to flue diameter, and hanger rods attached to structure. Support spacing is to be in accordance with vent manufacturer's instructions.
- C. Support vertical flue sections inside building at roof level and wherever else required by means of purpose made vertical support accessories supplied by manufacturer.
- D. Hand flashing collars to roofing trade at site on roof for installation and flashing into roof construction. Install counter-flashing pieces over collars.
- E. Equip termination of each chimney with a rain cap. Confirm height requirement for chimney above roof prior to installation, and ensure proper distance from fresh air intakes is maintained.
- F. Provide braided stainless steel aircraft cable guy wires attached to roof anchors and to stainless steel strap anchors on the vents as required and/or shown.
- G. Where required, anchor and restrain vents in accordance with local governing code requirements for seismic control and restraint.
- H. Provide required accessories, including insulated thimbles at building wall penetrations, barometric damper(s), cleanout(s), fire stops, and expansion joints where shown and/or required.
- I. Locate and install barometric dampers in accordance with manufacturer's instructions and field adjust to suit operating conditions.

**END OF SECTION**

**SECTION 23 75 00**  
**CUSTOM-PACKAGED HVAC EQUIPMENT**

**PART 1 – GENERAL**

**1.01 REQUIREMENTS**

- A. The CONTRACTOR shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning system as indicated on the Drawings and specified herein.
- B. Each custom MAU shall be furnished and installed to operate as a system. The CONTRACTOR shall coordinate all requirements between Manufacturers to insure unit responsibility and compatibility of the systems.
- C. Work Included Under Other Sections:
  - 1. 480V, 3-phase power wiring and conduit under Division 26 – Electrical.
  - 2. 120V, 1-phase wiring and conduit to Control Panels under Division 26 – Electrical.
- D. Unit flow requirements and other data are indicated on the Drawings.

**1.02 RELATED SPECIFICATIONS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.
- B. All Divisions of the Project Specifications are directly applicable to this Section, and this Section is directly applicable to them.
- C. Control Panels and Electrical wiring shall conform to the requirements of Division 40 – Process Interconnections and Division 26 – Electrical.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
  - 1. The CONTRACTOR shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01 33 00 – Submittal Procedures.
  - 2. Data to be submitted shall include but not be limited to:

- a. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
- b. Include all specification technical exceptions in the submittal. The manufacturer agrees that the equipment is in compliance with Specification Sections that are not identified in the list of technical exceptions.
- c. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
- d. Weight of all component parts and assembled weight.
- e. Electrical characteristics, wiring, diagrams, etc.
- f. Sample data sheet of equipment nameplate(s) including information contained thereon.
- g. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.
- h. Details of special fasteners and accessories.
- i. Type of adhesives, binders, joint cement, mastics.
- j. Proposed insulation procedures and installation methods.
- k. Spare parts list.
- l. Special tools list.
- m. Control Panels:
  - 1) Panel layout drawings indicating dimensions and device layout for panel mounted devices, sub-panel mounted devices and internal components.
  - 2) Wiring schematics indicating factory installed wiring as well as field installed interconnection wiring between control panels, and remote mounted equipment.
  - 3) Catalog data for all control panel components including but not limited to enclosures, controllers, starters, pilot lights, selector switches, pushbuttons, etc.

- n. The CONTRACTOR shall obtain from the Manufacturer and submit to the OWNER copies of the results of all certified shop tests.
- o. The CONTRACTOR shall submit written confirmation from the MAU Manufacturer's technical representative that each unit was installed per the manufacturer's requirements.
- p. The CONTRACTOR shall obtain from the manufacturer and submit to the OWNER copies of certified letters of compliance in accordance with the Specifications.
- q. Closeout Submittals: Submit warranty documentation.
- r. The CONTRACTOR shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01. Operation and Maintenance Manuals shall be submitted for all equipment.
- s. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.
- t. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

#### **1.04 DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 01.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

#### **1.05 SPARE PARTS**

- A. Provide one additional set of specified fan belts, sheaves, and filters for each unit, packaged for storage. Tag products to identify associated unit.

#### **1.06 SCHEDULES ON DRAWINGS**

- A. In general, all capacities of equipment and motor and starter characteristics are indicated in schedules on the Drawings. Reference shall be made to the schedules for

such information. The capacities indicated are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the OWNER.

- B. Motors and wheel diameters indicated on the schedules are the minimum. If a larger wheel diameter or horsepower is required, it shall be so quoted and noted.

#### **1.07 MANUFACTURER'S INSTRUCTIONS**

- A. Installation of all equipment shall be in accordance with Manufacturer's data.
- B. All changes from the installation procedures in Manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all Manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the OWNER and the use of other trades.
- E. Turn over all data to the OWNER at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 01.

#### **1.08 CODES, PERMITS AND STANDARDS**

- A. The CONTRACTOR shall obtain and pay for all permits (unless specifically excluded under Division 01 requirements) and shall comply with all laws and codes that apply to the Work.
- B. The CONTRACTOR shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State/Commonwealth rules and regulations or publications including those of the State/Commonwealth Fire Marshall, the International Mechanical and Energy Codes, and all local codes. Nothing in the Drawings and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:
  - 1. Air Conditioning and Refrigeration Institute (AHRI).
  - 2. Air Diffusion Council (ADC).



3. Air Moving and Conditioning Association (AMCA).
4. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).
5. American National Standards Institute (ANSI).
6. American Society for Testing and Materials (ASTM).
7. American Society of Mechanical Engineers (ASME).
8. Factory Mutual (FM).
9. National Electric Code (NEC).
10. NFPA 90A – Air Conditioning and Ventilation Systems 2009 edition.
11. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
12. Occupational Safety and Health Standards (OSHA).
13. Sheet Metal & Air Conditioning Contractor's National Association (SMACNA).
14. State/commonwealth and local codes, ordinances and statutes.
15. Underwriters Laboratories (UL).
16. Others as designated elsewhere in the specifications.

#### **1.09 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years of documented experience, who issues complete catalog data on total product.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the Manufacturers and in accordance with specified codes and standards.

- E. Touch up and/or repaint to match original finishes on all factory finished or painted equipment and materials which are scratched or marred during shipment or installation shall be performed as follows:
  - 1. Immediately after installation, sand smooth any rusted or damaged areas of shop paint and primer.
    - a. Furnish air-drying touch-up paint and compatible air-drying primer to be applied by the CONTRACTOR.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and control panels and terminal blocks, mechanical equipment, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Drawings.
- C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.
- D. The CONTRACTOR shall ascertain that all chassis, shafts, and openings are correctly located otherwise they shall cut all new openings as required at no additional cost to the OWNER. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the OWNER for review and acceptance prior to cutting.
- E. The Drawings shall be taken as diagrammatic. The CONTRACTOR shall check the Structural drawing information for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is indicated.
- F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the OWNER.
- G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Rotating equipment shall be supported on spring type vibration isolators.

**2.02 MANUFACTURERS**

- A. Provide custom make-up air unit(s) manufactured by one of the following:
  - 1. Innovent Air Handling Equipment (Basis of Design)
  - 2. Engineered Air
  - 3. Haakon Industries
  - 4. MAFNA
  - 5. Or equal
- B. Custom make-up air units shall conform to the requirements of this Specification, shall have the performance as listed in the equipment schedule and information indicated on the Contract Drawings, the component order, and dimensions as indicated on the Contract Drawings.
- C. The units shall be factory assembled on an integral base frame, wired, and tested for all operating functions before shipping.
- D. The units shall be approved for outdoor operation in designated ASHRAE design temperature location.
- E. The units shall bear certification label from ETL or UL and shall certify entire unit assembly as a system.

**2.03 MAKE-UP AIR UNIT CONSTRUCTION**

- A. The casing shall be able to withstand up to 1.5 times the design static pressure at the fan zero air flow with no more than 0.005-inch deflection per inch of panel span.
- B. Unit base shall be fabricated from C-channels with all joints fully welded. Base shall be 304 or 316L-stainless steel.
- C. Exterior walls, roof, down turn plenum and floor shall be 18-gauge Type 316-stainless steel.
- D. Double wall construction insulation and interior metal liner: Casing walls, roof, down turn plenum and floor shall be insulated with 2-inch thick, 3.0 lbs/cubic foot neoprene coated fiber glass or filled foam (R 8.7) insulation with vapor barrier and provided with 22-gauge Type 316 stainless steel inner liner.
- E. Floor wearing surface shall have a 2-inch turned up lip around the entire perimeter. All seams in the floor wearing surface shall be continuously welded. All opening in the floor shall be framed by a collar which extends 2-inches above the wearing surface. Floor

sheets shall be welded to all perimeter and intermediate base frame members. Floor wearing surface shall be 18-gauge Type 316L stainless steel.

- F. Unit shall be designed for 4- or 6-point lift.
- G. Provide access doors as required for access to all internal components and controls requiring maintenance or service. Access doors shall be insulated. Doors shall be double pan construction with fully-welded corners and all pan joints continuously sealed with a butyl rubber sealant. Doors shall be mounted such that doors in negatively pressurized sections shall open out of the unit and doors for positive pressure sections shall open into the unit to prevent doors from popping open as soon as they are unlatched. Door frame shall be fabricated from brake-formed angles of same material required for unit wall casing construction. Frame shall be fitted with a continuous neoprene bulb gasket. Door thickness shall be 2-inches. Each door shall have full length Type 316 stainless steel hinges. Hinges shall be welded or bolted to the door frame and the door pan. Each door shall have two chrome-plated metallic handles. Handles and shall be operable from either side of the door. Doors exposed to weather shall be fitted with tiebacks and drip guards above the top of the door and on the bottom of the door for in-swinging doors.
  - 1. Each access door shall include one 12-inch diameter or 10-inch square dual pane tempered glass viewing window.
- H. All units shall be furnished in modular construction. The contract documents indicate the minimum dimensions for the path of ingress of the MAU sections. The CONTRACTOR is responsible for field verifying that the MAU sections will fit in their proposed path of ingress. The unit construction shall be of modular construction and shipped to the site for field assembly. The unit shall come with full assembly instructions for assembling the unit pieces including, wiring diagrams, assembly details, section numbers and arrangements, bolting torques and patterns, etc.
- I. Each section of the MAU cabinet shall be provided with a unit drain. The cabinet floor shall be sloped to the drain point. The drain shall be capped on the exterior of the unit and is intended for washdown only. A trap is not required.

## **2.04 FAN ASSEMBLY**

- A. Original source for fans shall be the manufacturing facilities of one of the following available manufacturers:
  - 1. Twin City Fan.
  - 2. New York Blower.
  - 3. Greenheck.
  - 4. Or equal.

- B. Fans shall be single assembly type arranged for even air distribution over the heat exchanger.
- C. Fan wheels shall be backward-inclined aluminum (see coating specified below) and mounted on a type 316 stainless steel shaft selected for operation a minimum of 20% below the first critical RPM.
- D. Bearings shall be the grease lubricated pillow block type supported on a rigid structural epoxy coated steel frame. Fan bearings shall be rated for 80,000 hours AFBMA L-10 life at maximum fan RPM operating conditions.
- E. Motors shall be mounted on an adjustable base. Motors 7.5 HP and smaller shall be equipped with a variable pitch V belt drive when not supplied with a VFD.
- F. Fan motor assembly shall be provided with internal vibration isolation and a neoprene coated flexible connector between the fan outlet and fan section wall. Vibration isolators shall be coated with epoxy coating system specified below.
- G. Motors shall be TEFC premium efficiency (except motors in Classified areas shall be explosion proof rated for Class 1 Division 1), 460 Volt, 3-phase, 60 Hz. and have a 1.15 service factor.

## **2.05 GAS FURNACE**

- A. Description: factory assembled, piped, and wired: complying with ANSI Z21.47 and NFPA 54.
  - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
  - 1. Fuel: Natural gas.
  - 2. Ignition: Electronically controlled electric spark or hot surface igniter with flame sensor.
- C. Heat Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented.
- E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- F. Safety Controls:
  - 1. Gas Control Valve: Two stage or modulating.

2. Gas Train: Single body, regulated, redundant, 24-V gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

G. Burner Control Panel:

1. Provide a burner control panel to operate burner and draft inducer including all necessary components and safeties factory wired for proper burner operation.

## 2.06 FILTER SECTION

- A. Filter sections shall have filter racks and block-offs fabricated from Type 316 stainless steel or aluminum as required to prevent air bypass around filters.
- B. Units shall be supplied with two-inch angled filters unless indicated otherwise on the equipment schedules or MAU detail drawings.
- C. Filters shall be arranged in a V-bank configuration to minimize air pressure drop. Filters shall be deep pleated 2-inch filters with a MERV 11 rating (60-65% ASHRAE 52.1) unless indicated otherwise in the equipment schedule.
- D. Provide photohelic pressure switch with local indicating gauge. Gauge shall be ranged for 0-2" WC unless required otherwise by the provided filters. Switch shall use type 316 stainless steel instrument tubing for air sensing lines. Switch shall Dwyer Series A3000 with low temperature option.

## 2.07 HEAT EXCHANGER

- A. Heat exchangers to be crossflow plate style heat exchangers or heat pipes suitable for moist and hydrogen sulfide laden air.
- B. Provide face and bypass to close off heat exchanger for summer operation. Bypass channel shall be sized for the entire airflow capacity of the unit.
- C. Air-to-Air Energy Recovery Ventilators (ERV):
  1. Air to air recovery ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated single wall painted 22-gauge aluminum cabinet, for both intake and exhaust air, enthalpy core. Entire unit with the exception of field installed components shall be assembled and test operated at the factory.
  2. The ERV shall have pressure taps on the unit door and onboard adjustable airflow controls for easy airflow balancing of unit.
- D. Heat Pipes: (Alternate Heat Exchanger Style)

1. The Heat Pipe supplier shall have a minimum of 5 years of experience designing and installing Heat Pipes specifically for dehumidification applications.
2. The tubes shall be 1/2" OD copper, of specific design for Heat Pipe application, permanently expanded onto the fin collar to form a firm, rigid, and complete pressure contact at all operating conditions. Aluminum tubes will not be allowed.
3. The fin surface shall be continuous plate type  $\theta$  aluminum  $\theta$  copper fins of specific design to produce maximum heat transfer efficiency for Heat Pipe applications. Airside pressure loss shall be as given on the schedule, or otherwise specified. Fin density and the number of rows of tubes shall be as specified.
4. The Heat Pipe modules shall have an optional protective coating of E-Coat, similar to Electrofin or phenolic, similar to Heresite. Heat pipes shall be dipped and completely submerged to insure full coverage of coating - spray coatings are not acceptable.
5. Heat transfer fluid shall be classified as Safety Group A1 in ASHRAE Standard 34-2013.
6. Heat Pipe capacities, entering and leaving dry and wet bulb temperatures, and face velocity shall be as specified.
7. The Heat Pipes shall be installed as shown on the submittal drawings.
8. Frames, mounting structure, and drain pan extensions (if required) shall be minimum 16 gauge  $\theta$  galvanized steel  $\theta$  stainless steel.
9. Heat Pipe interconnecting piping and circuitry shall be as specified by Heat Pipe Technology design. Each circuit shall be individually processed, charged, hermetically sealed, and tested.
10. Scheduled effectiveness or heat recovery shall be met at a minimum and total pressure drop shall not be exceeded. The resulting Recovery Efficiency Ratio, or RER, shall therefore be met at a minimum.
11. The Heat Pipes shall be ETL listed to UL standard 207 and CSA C22.2.140.3.
12. The Heat Pipe heat exchanger shall have a five (5) year limited warranty. All components such as valves and dampers shall carry a 12 month warranty.

## **2.08 EVAPORATIVE COOLER**

- A. Units must be a self-contained direct, weather resistant drip, type, blow through with a mist eliminator and must conform to UL 507 and UL 746C. Unit must be the side discharge type as indicated.

- B. Water distributor must be separately controlled and provided with a sensor to verify to media is thoroughly wetted. Remote manual switch with pilot indicating light must be provided where indicated.
- C. Evaporative Media: Media must be fabricated of bonded synthetic fiber. Media must conform to UL 900 Class II. Media must be of the type specifically manufactured for use with evaporative coolers. Nonferrous metal media must be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. Media must be securely mounted in a galvanized steel, stainless steel, or polymeric material frame. Louvers must be positioned in such manner that the water will not run on the outside surface. Nonrigid filter media must be held in frame by a rigid retainer grid, a 6 mm 1/4 inch wire mesh or fabric netting.
- D. Water Handling Equipment for Drip Coolers: Water handling equipment must thoroughly wet and continuously flush evaporative surfaces of the media material. The water distribution system must be designed, to provide equal flow of water directly to the pads or to each trough. Troughs, if used, must be adjustable stainless steel, or polymeric and suitably designed in a manner that will effectively regulate the flow of water to the media pad to obtain even and complete saturation. Troughs must be adjustable for leveling or sectionalized and each section supplied with water by means of an individual tube.
- E. Water Blowdown Equipment: Water must be periodically dumped (approximately every six to twelve to 13hours). This must be done by either the use of a mechanical timer or by measuring the conductivity and dumping the water when the conductivity reaches 1500-2000 micro mhos.
- F. Water Pump: The water pump must be a self-priming centrifugal type with capacity and head characteristics for the manufacturer's determined flow and head pressure for proper operation of the unit. The motor shaft must be constructed of stainless steel, cadmium coated steel or hot-dip zinc galvanized steel. The impeller must be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing must be constructed of factory[painted steel or polymeric material conforming to UL 746C. Pump housing bottom must be removable for impeller cleaning and must not permit galvanic action with cooler bottom. Water pump must be provided with a filter screen constructed of plastic which must project 25 mm 1 inch above the high water level of the water tank.
- G. Evaporative Cooler Control Panel:
  - 1. Provide a factory wired control panel which contains all the necessary components and safeties for proper operation of the evaporative cooling system.
  - 2. Outside air temperature, space temperature and space humidity sensor inputs shall be provided from the SCADA system.



## **2.09 INTERIOR LIGHTING AND CONVENIENCE RECEPTACLES**

- A. Washdown proof lights shall be provided in all units. Lights shall be cast aluminum base style with glass globe and cast aluminum guard and 60 watt, or equivalent light output, lamp. Provide one light in each section where an access door is provided for maintenance or includes either a fan, damper, filter rack, coil, or wheel. A switch shall control the lights in each compartment (one switch per light). All wiring shall run neatly installed in rigid aluminum conduit run parallel and/or perpendicular to interior walls and terminate in the MAU electrical enclosure in terminal strips. The lighting circuits shall be 115 VAC and powered from a separate 120V circuit provided by Division 26. Wiring and conduit shall conform to Section 26 05 33.13 – Conduit for Electrical Systems.

## **2.10 DAMPERS**

- A. Unit mounted dampers shall be provided in accordance with the applicable damper section in Section 23 31 13 – Metal Ducts and Duct Accessories based on the material and type of damper being furnished. Damper materials shall match the interior unit casing material unless otherwise specified. Dampers for outside air intake shall be thermally insulated double walled type damper blades with a minimum R Value of 4.9.
- B. Unless otherwise specified, all units shall be equipped with motorized dampers for all duct connections or outside air intakes. Dampers shall be integral to the unit.
- C. Damper actuator's power and end switches shall be wired to a terminal strip located in the MAU electrical enclosure.
- D. Damper actuators shall be in accordance with Paragraph 2.13-B) of this Specification.

## **2.11 CORROSION COATING SYSTEM**

- A. Provide a corrosion coating system on all unit component surfaces except stainless steel surfaces. The coating shall be suitable for use for air typically found at a Wastewater Treatment Facility which shall include warm moist air containing 5 ppm hydrogen sulfide. Equipment located outside shall also be suitable to exposure to brackish marine air.
- B. Coating shall be a dipped or electrostatically spray applied baked enamel coating system to ensure complete coverage. Coating system shall be Heresite P-413C, Blygold, Inralac, or equal. For equipment installed outdoors, if the coating system is not suitable for UV exposure, a UV resistant topcoat shall be applied.

## **2.12 FACTORY SUPPLIED CONTROLS/WIRING:**

- A. The natural gas fired furnace control panel shall have a single point power connection.
- B. The evaporative cooler control panel shall have a single point power connection.

- C. All other unit mounted equipment, controls, and instruments shall be pre-wired to terminal blocks in junction boxes. Power, controls, and instrumentation wiring shall be installed in separate junction boxes.
- D. All factory and field installed cable shall be run in rigid aluminum conduit. Conduits shall conform to Section 26 05 33.13 – Conduit for Electrical Systems. Conduits shall be routed to junction boxes provided for each shipping section as determined by the manufacturer.

## 2.13 CONTROLS

### A. Control Panels:

1. Provide integral control panels completely factory pre-wired with necessary sensors and controls for natural gas fired furnace.
2. Provide integral control panels completely factory pre-wired with necessary sensor and components for evaporative cooler,
3. Control panels shall conform to the requirements of Division 40 specifications.
4. All fans shall be prewired and controlled from variable frequency drives (VFD) provided in a motor control center under Division 26. Factory pre-wire all fans to terminal blocks within a common power junction box.
5. All unit mounted sensors and electrical devices shall be factory pre-wired to terminal blocks for control by the SCADA System. The Control System shall be provided and wired by the SCADA CONTRACTOR.
6. Damper actuators shall be controlled by relays provided by the SCADA contractor. Each damper shall be controlled by a separate relay. The MAU manufacturer shall furnish any transformers or power supplies required. The damper relay coil contacts shall be wired to terminal blocks for control by the SCADA Control System. The relay coil voltage shall be coordinated with the SCADA Control System supplier. Relays shall be socket type ice-cube relays.

### B. Damper Actuators:

1. Type: Electric, direct coupled (over the shaft).
2. Spring return or proportional as indicated in the Sequence of Operations.
3. V-bolt and V-shaped cradle damp shaft attachment.
4. Mechanical spring return mechanism; Proportional (non-spring return) shall have an external manual gear release.

5. Electronic overload or digital rotation sensing circuitry to prevent damage to actuator throughout rotation of actuator.
6. Reversible rotation by changing mounting orientation.
7. Factory mounted electrical cable and conduit fitting for connection to junction box.
8. UL Standard 873.
9. Min. torque 133-in-lb., for control of damper surface up to 35 ft<sup>2</sup>.
10. 120 VAC.
11. Multiple actuators may be required for devices requiring more than 133-in-lb torque, the MAU manufacturer is responsible for determining torque required and providing the applicable quantity of actuators.
12. Damper actuators shall fail close unless indicated otherwise in the equipment schedule.
13. Accessories:
  - a. Angle of rotation limited.
  - b. Damper linkage kit.
  - c. Mounting bracket.
  - d. Open and Close end switches.
  - e. If the actuator is not rated NEMA 4X, an external NEMA 4X enclosure shall be provided
14. Manufacturer:
  - a. Belimo, Series: AF120-S.
  - b. Honeywell Series: MS4120A
  - c. Johnson Series: M9220
  - d. Or equal.

C. Control Sequence of Operation:

1. The SCADA Control System shall control unit functions such as opening dampers, starting fans, and dampers. The SCADA Control System shall be provided by the SCADA Contractor in accordance with Division 40.

2. Instruments and electrical devices provided in or by the MAU manufacturer shall be wired to terminal blocks located in the MAU manufacturer's unit mounted electrical enclosure.
3. Control Sequence of Operation shall be as defined in 23 09 00- HVAC Automatic Temperature Controls. MAU manufacturer shall review the P&IDs and Specification Section 23 09 00 – HVAC Automatic Temperature Controls and provide all unit mounted equipment, sensors, and instruments shown.

#### **2.14 NAME PLATES**

- A. White laminated phenolic plastic with minimum 3/16-inch-high black engravings if viewing distance is less than 24 inches, 1/2-inch high lettering for distances up to 72-inches, and proportionately larger lettering for greater distances.
- B. Nameplates shall be affixed with weatherproof adhesive.

#### **2.15 GASKETS AND CONNECTORS**

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with Manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and fasteners for makeup of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

#### **2.16 SPECIAL TOOLS AND SUPPLIES**

- A. Furnish all special tools, supplies, and parts necessary to install, disassemble, service, and repair the equipment.
- B. Items shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each item shall be properly identified by a separate number. Those items which are identical for more than one size, shall have the same part number. Items shall be packed in individual, suitable containers clearly labeled with the part number; name, quantity, and the equipment for which they are intended.
- C. Tools, supplies, and parts shall be delivered at the same time as the equipment to which they pertain. The CONTRACTOR shall properly store and safeguard such items until completion of the work, at which time they shall be delivered to the OWNER.

## **PART 3 – EXECUTION**

### **3.01 SHIPPING AND STORAGE**

- A. Each MAU section shall be shipped from the factory in a manner suitable for long term storage. At a minimum, the following shall be performed:
1. Coils shall be purged, pressurized, and sealed with a dry nitrogen charge. Piping connections shall be closed with a blind flange.
  2. Each section shall be self-supporting for picking and placement with any required stiffeners or braces installed in the factory. No additional temporary supports or stiffeners shall be needed during installation. Any temporary bracing shall be clearly marked for the CONTRACTOR to remove prior to starting the unit.
  3. Open sections shall be closed with a rigid covering.
  4. Moving components shall be suitably secured or restrained to prevent damage during shipment and storage.
  5. Instruments, hardware, and other appurtenances that are shipped loose shall be packed in secure rigid containers. The containers shall be labeled as to what the contents is and the quantity.
- B. Where indicated on the Contract Drawings that the MAU shall be of modular construction the CONTRACTOR is responsible for field coordinating the maximum MAU section size that will fit through the means of ingress to the final unit location.

### **3.02 INSTALLATION**

- A. The custom MAU system installer shall have at least five (5) consecutive years regularly engaged in the business of installing MAU systems similar to the custom MAU system to be installed under this Contract, and during such time period shall have successfully installed five (5) MAU system projects of similar type and size as to be installed under this Contract. The installer shall be certified by the MAU manufacturer as possessing training necessary for installing the Manufacturer's products.
- B. Installation shall meet or exceed all applicable federal, state/commonwealth and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- C. All installations shall be in accordance with Manufacturer's published recommendations.
- D. All exterior equipment shall be properly secured and anchored to the structure.

- E. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation of the OWNER.
- F. MAU sections shall be assembled per the Manufacturer's instructions. A technical representative of the MAU manufacturer shall inspect the assembly of each multi-section unit prior to energizing or running tests on any unit. The representative shall provide written confirmation that each unit is installed per the Manufacturer's requirements. The CONTRACTOR shall submit the written confirmation for the record.
- G. The equipment shall be tested and balanced per Section 23 05 93 –HVAC Balancing.

### **3.03 MANUFACTURER'S SERVICES**

- A. Furnish the services of certified factory trained service personnel of the MAU manufacturer to assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct plant operators in the care, operation, and maintenance of the equipment. A certificate from the Manufacturer relative to these services is required.
- B. Certified factory trained service personnel shall not make less than three (3) visits to the Site as necessary to assist in the installation of the equipment, to check the completed installation, and to perform the tests.
- C. Training: In addition to the above requirements, furnish the services of the Manufacturer's factory-trained representative to instruct and train plant operators in accordance with the requirements of Section 01 79 00 – Instruction of Owner's Personnel.

### **3.04 CLEANING**

- A. Clean dirt and marks and other debris from exterior of equipment weekly.
- B. Remove debris and waste material resulting from installation weekly.

### **3.05 WARRANTY**

- A. The CONTRACTOR shall obtain from the Manufacturer its warranty that the custom MAU system will be free from defects in design, materials, and workmanship for a period of 3 years. Said warranty, containing no exclusions or limitations, shall be in a form acceptable to, and for the benefit of the OWNER and shall be submitted by the CONTRACTOR as condition of final payment.
- B. For a period of 3 years from the date of Substantial Completion, the CONTRACTOR warrants to the OWNER that the custom MAU system conforms to these Specifications and is free from defects in materials and workmanship. The CONTRACTOR shall repair or replace, at the sole option of and at no additional cost to the OWNER, any work found

to be defective within said warranty period. Such repair or replacement shall include the cost of removal, disposal, and reinstallation of any MAU equipment, appurtenances, or items.

- C. The warranty obligations pursuant to Paragraph 3.05 herein are in addition to, and not a limitation, of any other remedy the OWNER may have under Contract Document provisions, or law.

**END OF SECTION**

**SECTION 23 81 26**  
**SPLIT-SYSTEM AIR CONDITIONERS**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

**1.02 SUMMARY**

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the air conditioning (heat pump) system as indicated on the Drawings and specified herein.
- B. Heating, Ventilating and Air Conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to ensure unit responsibility and compatibility of the systems.
- C. Work Included Under Other Sections:
  - 1. 208, 1 phase, 3-phase and 480V, 3-phase power wiring and conduit under Division 26 – Electrical.

**1.03 SUBMITTALS**

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01 33 00 – Submittal Procedures.
- B. Data to be submitted shall include but not be limited to:
  - 1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories.
  - 2. Electrical characteristics, wiring, diagrams, etc.
  - 3. Piping connection drawings.



4. Include all specification technical exceptions in the submittal. The manufacturer agrees that the equipment is in compliance with Specification Sections that are not identified in the list of technical exceptions.
- C. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 01. Operation and Maintenance Manuals shall be submitted for all equipment.
1. Include instructions for lubrication, filter replacement, motor replacement, spare parts lists and wiring diagrams.
  2. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

#### **1.04 DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 01.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- C. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

#### **1.05 EXTRA MATERIALS**

- A. Provide one additional set of filters for each unit, packaged for storage. Tag products to identify associated unit.

#### **1.06 SCHEDULES ON DRAWINGS**

- A. In general, all capacities of equipment and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.
- B. Motors sizes shown on the schedules are the minimum. If a larger motor horsepower is required, it shall be so quoted and noted.

#### **1.07 INDUSTRY STANDARDS**

- A. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. Air Conditioning and Refrigeration Institute (AHRI)
2. Air Moving and Conditioning Association (AMCA)
3. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
4. National Electric Code (NEC)
5. NFPA 90A – Air Conditioning and Ventilation Systems 2009 edition
6. State/Commonwealth and local codes, ordinances and statutes
7. Underwriters Laboratories (UL)
8. Others as designated in the specifications.

#### **1.08 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years of documented experience, who issues complete catalog data on total product.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- E. Touch up and/or repaint to match original factory finishes or specially applied corrosion resistant coatings for all finished or painted equipment and materials which are scratched or marred during shipment or installation.

### **PART 2 – PRODUCTS**

#### **2.01 AIR CONDITIONING UNITS**

- A. Provide air conditioning unit(s) manufactured by one of the following:
  1. Trane (Basis of Design).
  2. Carrier.

3. York, Division of JCI (Johnson Controls)
  4. Or Approved Equal.
- B. Air conditioning units shall be complete package with air handler matched with air cooled condensing unit. Controls shall be factory mounted and wired.
- C. Air Cooled Condensing Unit (Heat Pump):
1. General: Units shall include hermetic scroll compressors, plate fin condenser coils, fans and motors, controls and holding charge of nitrogen. Operating range shall be between 115°F and 0°F in cooling.
  2. Casing: Unit casing shall be constructed of zinc coated galvanized steel. Casing surfaces shall be finished with HERESITE VRL-506 (gray) air dry phenolic coating system. Units shall have removable panels which allow access to all major components and controls.
  3. Refrigerant System: The air handling unit shall have a single refrigeration circuit. All refrigerant circuits shall be controlled by a factory-installed thermal expansion valve.
  4. Compressors: Crankcase heater, internal temperature and current-sensitive motor overloads shall be included for maximum protection. Scroll compressor shall provide inherently low vibration and noise by having no suction and discharge valves. External high and low pressure cutout devices shall be provided. Evaporator-defrost control provided in indoor blower coil shall prevent compressor operation when low evaporator coil temperatures are encountered.
  5. Condenser Coil: Coils shall be internally enhanced 3/8-inch copper tubes mechanically bonded to configured aluminum plate fins. Coils shall be factory pressure and leak tested. Coils shall be coated with HERESITE P413-C baked phenolic coating system. Provide condenser coil guard grille.
  6. Condenser Fan and Motor(s): Direct-drive, statically and dynamically balanced propeller fan(s) shall be used in draw-through vertical discharge position. Fans shall be aluminum construction and coated with HERESITE VRL-506 (gray) air dry phenolic coating system. Either permanently lubricated totally enclosed or open construction motors shall be provided and shall have built in current and thermal overload protection. Motor(s) shall be either ball or sleeve bearing type.
  7. Controls: Condensing units shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Units shall have single point power entry. Low Ambient Operation: Head pressure control shall be provided to permit operation to 0°F outdoor ambient temperature.
- D. Blower coil air handling unit:

1. Blower coil units shall be completely factory assembled including coil, condensate drain pan, fan motor, filters and controls in an insulated casing that can be applied in either vertical or horizontal configuration. Units shall be rated and tested in accordance with ARI Standard 210/240, 340/360. Units shall be UL listed and labeled.
2. Casing: Unit shall be constructed of sheet metal and steel frame with removable front or side panels. Removal of panels must not affect the structural integrity of unit. All exterior wall panels shall be made of minimum 20-gauge baked enamel finished (Heresite VR-508 coating on both sides of unit casing) steel. Casing shall be insulated with knockouts provided for electrical power, control wiring and piping connections.
3. Evaporator Coil: Configured aluminum fin surface shall be mechanically bonded to 3/8-inch OD copper tubing. Coils shall be factory pressure and leak tested. Coils shall be coated with HERESITE P413-C baked phenolic coating system.
4. Evaporator Fan: Forward curved (FC), centrifugal-type fan(s) with multi-speed direct drive. All fans statically and dynamically balanced and tested after being installed on properly sized hollow or solid shafts. Fan shafts shall not pass through their first critical speed as unit comes up to rated rpm. Fan wheels shall be coated with HERESITE VR-508 air dry phenolic coating system. Thermal overload protection shall be provided for the motor. Fan and motor bearings shall be permanently lubricated. Oversized motors shall be available as an option for high static application. All motors shall meet the US Energy Policy Act of 1992 (EPACT).
5. Controls: Magnetic evaporator fan contactor, low voltage terminal strip, check valve(s), single point power entry and plug in module for accessory electric heat control shall be included. All necessary controls shall be factory installed and wired. Evaporator defrost control shall be included to prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered. A space zone sensor shall be provided by unit manufacturer.
6. Electric Heater (If Scheduled on Drawings): The electric coil along with the complete air handling unit shall be listed as an entire assembly by Underwriters Laboratories, Inc. with the appropriate UL labels. Electric coils in galvanized steel frames shall have open resistance type heating elements of 80 percent nickel and 20 percent chromium. Elements uniformly distributed over cross-sectional area of unit with vertical support brackets to prevent coil element sag. Coil elements insulated from metal by ceramic bushings. Maximum element heating density for preheat coils of 55 watts/inch<sup>2</sup> and hot deck coils of 35 watts/inch<sup>2</sup>. Expanded steel baffle provided on coil inlet for uniform airflow and protection of service personnel. Electric coils rated for 460/60/3 operation with equal, balanced, three-phase stages. Electric coils provided with built-in primary automatic and

secondary manual reset thermal protection devices, and static pressure type airflow switch that prevents energizing when airflow is inadequate.

7. Filters: Filters shall be accessible from either side coil access panel. Filter rack shall have low velocity, 2-inch pleated cotton or synthetic fiber, Merv 8 or 9, throw-away filters.

## 2.02 REFRIGERANT PIPING

### A. Products and Manufacturers:

1. Refrigerant piping specialties:
  - a. Sporlan.
2. Expansion valves:
  - a. Sporlan.
  - b. Alcoa.
3. Silver solder - "Easy-Flow 45":
  - a. Harman.
4. Moisture indicator - "SEE-ALL":
  - a. Sporlan.

### B. Refrigerant Piping:

1. Copper tubing conforming to ASTM B280 and/or FS WW-T-799, dehydrated for refrigerant use, with high-temperature soldered joints and wrought copper (400 psig) fittings.
  - a. For underground use: Type K.
  - b. For aboveground use: Type L.

### C. Piping Joints:

1. Joints between copper tubing and fittings to be high temperature brazed joint (melting point not less than 1000° F, Harris Products Stay-Silv 15. Do not use flux. Purge the line with nitrogen to prevent scale build up.
2. Joints between copper and brass, steel, etc., shall be silver soldered only, Harris Products Safety-Silv 45 with Stay-Silv White Brazing Flux.

- D. Pre-charged Line Sets: Size per manufacturer's recommendations.
- E. Field Assembled Units:
  - 1. Size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
    - a. Suction lines: 2 DegF.
    - b. Liquid lines: 1 DegF or 2 psi.
    - c. Hot gas lines: 1 DegF or 3.6 psi.
    - d. Size discharge and hot gas risers for positive oil return to compressors.
- F. Refrigerant Dryer:
  - 1. Sporlan material "CATCH-ALL" filter-drier with aluminum molded core.
  - 2. In each liquid line.
  - 3. A three-valve bypass around filter-drier.
  - 4. Install so core can be removed without cutting or breaking any refrigerant line.
- G. Moisture Indicator:
  - 1. Show presence of moisture in system by change of color.
  - 2. Install full size in the main liquid line adjacent to the filter-drier.
  - 3. Use Sporlan "SEE-ALL."
- H. Strainers:
  - 1. Design to permit removing screen without removing strainer from piping system.
  - 2. Screens not larger than 80 mesh.
  - 3. Strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.
- I. Oil Traps: Provide in lines as required.
- J. All Valves:
  - 1. All bronze.

2. 2 IN and less: Solder ends.
  3. 3 IN and over: Four (4) bolt union ends.
- K. Shut-Off Valves:
1. Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.
  2. Wheel, globe, angle or "T" handle.
- L. Check Valves:
1. In liquid lines 5/8 IN and less: Lift check type.
  2. In lines 3/4 to 2 IN: Swing check type.
  3. In lines 3 IN and over: Wafer type swing check with bronze disc.
- M. Expansion Valves:
1. Sized by manufacturer for refrigerant used.
  2. Provide one (1) in each circuit with liquid distributor connection immediately after.
- N. Vent and Test Valves: Angle cap type with seal and outlet caps.
- O. Pre-charged Line Sets: Install per manufacturer's recommendations.
- P. Field Assembled Lines:
1. Refrigerant piping:
    - a. Purge refrigerant piping of all air while connections of refrigerant piping are being made.
      - 1) Shut-off valves.
      - 2) Connect tank of dry nitrogen to line on back side of valve.
      - 3) Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.
  2. Testing:
    - a. Refrigerant piping systems: Follow general testing guidelines of ASHRAE 15, except as modified herein.

- b. Pressurize the high and low pressure sides of the piping system after completion of the refrigerant piping.
  - c. Pressurize at the test pressures specified in ASHRAE 15 for the refrigerant type to be used in the system.
  - d. Repair any leaks and repeat tests until no further leaks are found and the system passes a static leak test at test pressure for a duration of 24 HRS.
3. Cleaning:
- a. Disconnect suction and discharge lines from compressor for clean up after complete system is tested.
  - b. Valve or blank off system into three (3) separate systems for purpose of cleanup.
    - 1) Suction side including cooling coils.
    - 2) Discharge side including air cooled condenser.
    - 3) Hot gas reheat side including heating DX coils.
  - c. Thoroughly clean each system using pumped refrigerant until system is proven clean to satisfaction of refrigeration compressor serviceman.
  - d. Notify Engineer for a visual inspection of both cleaning process and completely cleaned system.
4. Evacuation and Drying:
- a. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to gas pressure as recommended by the equipment manufacturer.
  - b. Evacuate to 100-micron Hg and hold for 72 HRS.
    - 1) Use laboratory type vacuum pump capable of holding absolute pressure of 50-micron Hg.
    - 2) Check the vacuum with a suitable mercury column gauge.
  - c. Admit another drying charge of refrigerant and allow 4 to 6 HRS to absorb moisture and install dryer cores.
  - d. Use second evacuation to remove all refrigerant and moisture.
  - e. After second evacuation, charge system with refrigerant.



- f. Charge the system with refrigerant as required after final evacuation.

### **2.03 CONDENSATE DRAIN PIPE**

- A. Poly (Vinyl Chloride) Pipe and Fittings:
  1. Pipe: Drain, waste and sanitary pipes and fittings shall be DWV Schedule 40 PVC, ASTM D2665.
  2. Joints: Chemical weld with manufacturers recommended solvent.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. All installation shall be in accordance with manufacturer's published recommendations.
- B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation of the Owner's representative(s).
- C. Provide the minimum access space for maintenance of filters and coils as scheduled or shown on the Drawings. Arrange these components in a manner that allows for ease of replacement.

### **3.02 CLEANING**

- A. Clean dirt and marks and other debris from exterior of equipment.
- B. Remove debris and waste material resulting from installation.

### **3.03 GUARANTEE**

- A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of one (1) year. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

**END OF SECTION**

**SECTION 26 05 00**  
**BASIC ELECTRICAL REQUIREMENTS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental to, the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents, and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in, and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.
- B. Reference Section 40 61 13 – Process Control System General Provisions and General Requirements in Division 01 for scope of work details as they relate to the Division 40 Instrumentation and Control System Subcontractor.
- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
1. Demolition of electrical equipment and raceway systems as shown on the Drawings.
  2. Modifications to existing electrical equipment as shown on the Drawings and as specified herein.
  3. Furnish and install low voltage motor control equipment including variable frequency drives.
  4. Furnish and install lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.
  5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.
  6. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system.

7. Furnish and install new lighting systems and wiring devices.
  8. Furnish and install fire alarm systems where specified or indicated on the Drawings.
  9. Other electrical work as specified herein and indicated on the Drawings.
- D. All material and equipment shall be the product of an established, reputable, and approved manufacturer; shall be new and of first-class construction; shall be designed and guaranteed to perform the service required; and shall bear the Label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.
  - E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.
  - F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.
  - G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.
  - H. All electrical components and systems (e.g., conduit and other raceways, freestanding equipment, etc.) and their anchorage, including electrical equipment foundations, shall be designed to resist the controlling load combination of gravity loads, operational forces, wind forces, seismic forces, thermal loads, and any other applicable forces required in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components. Seismic design shall be in accordance with ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt.

## **1.02 EQUIPMENT LOCATION**

- A. The Drawings show the general location of feeders, transformers, equipment, devices, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting the work and shall arrange such work accordingly. Contractor shall furnish and install such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to

the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.

- B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

### **1.03 LOCAL CONDITIONS**

- A. The Contractor shall examine the site and become familiar with conditions affecting the work.

### **1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures and the requirements of the individual Specification Sections, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts List
  - 4. Proposed Testing Methods and Reports of Certified Shop Tests
  - 5. Reports of Certified Field Tests
  - 6. Manufacturer's Representative's Certification
- B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.
- C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.
- D. Some individual electrical specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations, and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall

include a copy of the applicable specification section(s). In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations and exceptions taken to each Drawing related to the applicable specification section(s).

- E. Submit design for all nonstructural electrical components and systems and their anchorage in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.

## **1.05 APPLICABLE CODES AND REQUIREMENTS**

### **A. Conformance**

- 1. Unless otherwise noted, all work, equipment, and materials furnished shall conform with the latest available version of the rules, requirements, and specifications of the following:
  - a. Insurance Rating Organization having jurisdiction.
  - b. The serving electric utility company.
  - c. The currently adopted edition of the National Electrical Code (NEC).
  - d. The National Electric Manufacturers Association (NEMA).
  - e. The Institute of Electrical and Electronic Engineers (IEEE).
  - f. The Insulated Cable Engineers Association (ICEA).
  - g. The American Society of Testing Materials (ASTM).
  - h. The American National Standards Institute (ANSI).
  - i. The requirements of the Occupational Safety Hazards Act (OSHA).
  - j. The National Electrical Contractors Association (NECA) Standard of Installation.
  - k. National Fire Protection Association (NFPA).
  - l. InterNational Electrical Testing Association (NETA).

- m. All other applicable Federal, State/Commonwealth, and local laws and/or ordinances.
2. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL), if the material and equipment is of the type/class inspected by said laboratories.

B. Nonconformance

1. Any paragraph of requirements in these Specifications or Drawings deviating from the rules, requirements, and specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements, and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Where applicable, upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

#### **1.06 PERMITS AND INSPECTIONS**

- A. The Contractor shall reference the General Conditions and Section 01 11 00 – Summary of Work.

#### **1.07 TEMPORARY LIGHTING AND POWER**

- A. The Contractor shall reference the General Conditions and Section 01 51 00 – Temporary Utilities.

#### **1.08 TESTS**

- A. Upon completion of the installation, the Contractor shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.
- B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no

cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

- C. Refer to each individual specification section for detailed test requirements.
- D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the start-up and testing of any equipment served by that electrical equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.
- E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, personnel, and scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed test procedures for any electrical equipment required as part of the field tests of other systems.

#### **1.09 INFRARED INSPECTION**

- A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared inspection to locate and correct all heating problems associated with electrical equipment terminations. The infrared inspection shall be performed by a qualified, independent, third-party testing company, not the Electrical Contractor.
- B. Equipment located in hazardous areas shall be excluded from infrared testing requirements since the equipment in those areas is not intended to be operated while the enclosure is open. The infrared inspection shall apply to all new equipment and existing equipment in non-hazardous areas that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor at no additional cost to the Owner. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor at no additional cost to the Owner.
- C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.
- D. The infrared inspection report shall include both digital photos and infrared (IR) photos positioned side by side. Both the digital and IR photos shall be clear and high quality. Fuzzy, grainy, or poorly illuminated photos are not acceptable. Each IR photo shall be provided with a temperature scale beside it, and an indication of the hot spot



temperature in the photo. Reports shall be furnished in a 3-ring binder, with all pages printed in full color, with equipment assemblies separated by tabs.

#### **1.10 PROTECTIVE DEVICE SETTING AND TESTING**

- A. The Contractor shall provide the services of a field services organization to adjust, set, calibrate and test all protective devices in the electrical system. The organization shall be a subsidiary of or have a franchise service agreement with the electrical equipment manufacturer. The qualifications of the organization and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.
- B. All protective devices in the electrical equipment shall be set, adjusted, calibrated, and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.
- C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity, and polarity tests of power, protective, and metering circuits. Any minor adjustments, repairs, and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
- D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers' recommended test devices and procedures.
- E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.
- F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults, and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.
- G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

#### **1.11 POWER SYSTEM STUDIES**

- A. The Engineer will provide the Power System studies to the firm providing the protective device setting and testing services. The Contractor shall submit to the Engineer a tabulated listing of all protective devices requiring setting at least three (3) weeks prior to the scheduled date for setting and testing of protective devices. This table shall include the protective device manufacturer, model number, ampere rating (if applicable), instrument transformer ratios, and all other required information.

## 1.12 SCHEDULES AND FACILITY OPERATIONS

- A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules shall be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer shall be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment shall be coordinated with the Owner/Engineer so as not to affect proper facility operations.
- B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.
- C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.
- D. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01 14 00 – Coordination with Owner's Operations for construction sequencing and specific operational constraint information.

## 1.13 EQUIPMENT, MATERIALS, AND SPARE PARTS HANDLING AND STORAGE

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01 55 00 – Contractor Access and Parking.
- B. Spare parts lists, included with the shop drawing submittal for each Section, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

- C. Spare parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.
- D. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- E. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

#### **1.14 WARRANTIES**

- A. Unless otherwise specified in an individual specification section, all electrical equipment and electrical construction materials shall be provided with a warranty in accordance with the General Conditions.
- B. Warranty requirements shall be as specified in Section 01 61 00 – Product Requirements and Options and Section 01 75 00 – Checkout and Startup Procedures. Warranty requirements are supplementary to the individual equipment specifications.

#### **1.15 TRAINING**

- A. Unless otherwise specified in an individual specification section, all training for electrical equipment shall be provided in accordance with the requirements of Section 01 79 00 – Instruction of Owner Personnel.
- B. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.

### **PART 2 – PRODUCTS**

#### **2.01 PRODUCT REQUIREMENTS**

- A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

- C. All equipment and materials shall be new, unless indicated or specified otherwise.
- D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, and/or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc. with regard to fire and casualty hazards. Documentation indicating Listing and Labeling by Underwriters Laboratories, Inc., will be accepted as meeting this requirement.
- E. Where the above items are Labeled by (bearing the certification mark of) an OSHA Nationally Recognized Testing Laboratory (NRTL) other than UL, and the NRTL is authorized by the Occupational Safety and Health Administration (OSHA) to test and certify those items to the same standard(s), then the certification mark of that NRTL shall be considered equivalent to the 'UL' certification mark.

## **2.02 SUBSTITUTIONS**

- A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

## **2.03 CONCRETE**

- A. The Contractor shall furnish all concrete required for the installation of all electrical work. Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 03 of the Specifications.
- B. The Contractor shall provide concrete equipment pads for all free-standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to the Standard Detail for equipment pads shown on the Drawings. Equipment pads shall not have more than 3 inches of excess concrete beyond the edges of the equipment.

## **2.04 RUBBER INSULATING MATTING**

- A. Rubber insulating matting shall be furnished and installed for each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. Matting shall be installed in the front of all equipment and in the rear of equipment that is rear accessible. The mat shall be long enough to cover the full length of the equipment. The mat shall be ¼-inch thick with

beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.

B. Matting shall be provided for the following equipment:

1. PLC/RTU Enclosures
2. Motor Control Centers
3. Variable Frequency Drives
4. Panelboards
5. Fire Alarm Control Panels

## **PART 3 – EXECUTION**

### **3.01 CUTTING AND PATCHING**

A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling, and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Contractor shall perform all chasing, channeling, drilling, and patching necessary to the proper execution of this Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at the Contractor's expense.

C. Existing Equipment

1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

### **3.02 CORROSION PROTECTION**

- A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

**END OF SECTION**

**SECTION 26 05 19**  
**LOW VOLTAGE CONDUCTORS AND CABLES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition all low voltage wire and cable indicated on the Drawings, as specified herein, and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.
- B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.
- C. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 33.16 – Boxes for Electrical Systems
  - 3. Section 26 28 16.16 – Enclosed Switches

**1.02 CODES AND STANDARDS**

- A. All low voltage wire, cable, and appurtenances shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
    - a. IEEE 1202 – Standard for Flame Testing of Cables.
  - 2. American Society for Testing and Materials (ASTM):
    - a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire.

- b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
  - d. ASTM D69 – Standard Test Methods for Friction Tapes.
  - e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
3. Insulated Cable Engineers Association (ICEA):
- a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification.
  - b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour.
4. National Fire Protection Association (NFPA):
- a. NFPA 70 – National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
- a. UL 13 – Standard for Power-Limited Circuit Cables.
  - b. UL 44 – Thermoset-Insulated Wires and Cables.
  - c. UL 83 – Thermoplastic-Insulated Wires and Cables.
  - d. UL 486A-486B – Standard for Safety Wire Connectors
  - e. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
  - f. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.
  - g. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
  - h. UL 2250 – Standard for Instrumentation Tray Cable.



- i. UL 2556 – Wire and Cable Test Methods.

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of Field Tests
  - 3. Circuit Logs
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets for the following:
    - a. Wire and cable
      - 1) The product data sheets for wire and cable for up to four (4) manufacturers for each type of wire/cable specified herein will be reviewed if they are submitted at the same time under the same submittal cover for simultaneous review.
    - b. Power and control wire terminations, including wire ferrules
    - c. Instrumentation cable terminations
    - d. Shielded VFD cable terminations
    - e. Pulling lubricant.

2. Cable pulling calculations (if required).
  3. Wiring identification methods and materials.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

### **1.05 CABLE PULLING CALCULATIONS**

- A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for Engineer review and approval when all of the following are true:
1. The amount of cable to be installed will be greater than 200 linear feet between pull points.
  2. The installation will have one or more bends.
  3. The wire/cable is size #1/0 AWG and larger.
- B. Cable pulling calculations shall be performed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located. Calculations shall define pulling tension and sidewall loading (sidewall bearing pressure values).

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

### **2.02 POWER AND CONTROL WIRE AND CABLE**

- A. Power wire installed between the output terminals of a VFD and the respective motor shall be shielded VFD cable as specified herein.

- B. Power wire for all other loads and control wire shall consist of insulated copper conductors with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.
- C. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size. Power conductors for lighting and receptacle branch circuits shall be solid copper per ASTM B-3.
- D. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.
- E. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- F. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or Engineer approved equal.

### **2.03 INSTRUMENTATION CABLE**

- A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e., groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e., group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.

- D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.
- E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.
- F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or Engineer approved equal.

#### **2.04 SHIELDED VFD CABLE**

- A. Where indicated on the Drawings, shielded VFD cable shall be installed between the output terminals of a VFD and the respective motor.
- B. Shielded VFD cable shall consist of three (3) individually insulated copper phase conductors and three (3) bare copper grounding conductors with an overall cable shield and jacket, suitable for use with variable frequency drives. The phase conductors and ground conductors shall be symmetrically arranged within the cable assembly. Conductor insulation shall be rated 90°C in both wet and dry locations, and 2000V (2kV). Insulated conductors shall be UL Listed as NEC Type RHW-2 or XHHW-2. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL Listed as NEC Type TC-ER (Tray Cable for Exposed Runs).
- C. Phase conductors shall be sized as shown on the Drawings. Ground conductors shall have a combined circular mil area equivalent to the equipment grounding conductor size required by NEC Table 250.122, minimum. Filler material shall be included in the cable assembly as necessary to make the cable round.
- D. Cable shields shall consist of a helically applied bare copper tape with 50% overlap, minimum. For small conductor sizes where copper tape shields are not available, shields shall be permitted to consist of a layer of tin-coated copper braid covered by a layer of overlapped aluminum/polyester tape/foil. All cable shields shall provide 100% coverage.
- E. Conductors shall be annealed, tinned, stranded copper per ASTM B3, B8, and B33.
- F. Shielded VFD cable shall be as manufactured by Belden Wire and Cable, the Okonite Company, General Cable, Southwire, or AmerCable Inc.

## 2.05 OTHER CABLES

- A. Category 6 UTP communication cables and fiber optic cables shall be as specified in Specification Section 40 66 00 – Network and Communication Equipment.

## 2.06 CONDUCTOR IDENTIFICATION

- A. Conductors shall be identified using a color-coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:

1. 480/277V AC Power
  - a. Phase A – BROWN
  - b. Phase B – ORANGE
  - c. Phase C – YELLOW
  - d. Neutral – GREY
2. 120/208V or 120/240V AC Power
  - a. Phase A – BLACK
  - b. Phase B – RED
  - c. Phase C – BLUE
  - d. Neutral – WHITE
3. DC Power
  - a. Positive Lead – RED
  - b. Negative Lead - BLACK
4. DC Control
  - a. All wiring – BLUE
5. 120 VAC Control
  - a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock.

This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above-mentioned equipment from a source outside that equipment.

6. 24 VAC Control
    - a. All wiring - ORANGE
  7. Equipment Grounding Conductor
    - a. All wiring - GREEN
- B. Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3 herein. Insulation colors and tape colors shall be in accordance with the color-coding requirements listed above.
- C. Conductors that are part of multi-conductor cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color-coding requirements listed above.

## **2.07 CABLE PULLING LUBRICANTS**

- A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

## **PART 3 – EXECUTION**

### **3.01 WIRE AND CABLE INSTALLATION**

- A. General

1. All wire and cable furnished under this Contract, including wire and cable furnished under other Divisions, shall be installed in raceways (e.g., conduit) unless specifically noted otherwise.
2. Wire and cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation wiring.
3. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.
4. Where instrumentation cables are installed in control panels, motor controllers, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.
5. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

#### B. Splices

1. Splices shall not be allowed in power or control wire and cable unless approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.
2. Splicing materials shall be UL 486A Listed barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.
3. No splicing of instrumentation cable is permitted.

#### C. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors

and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 2-1/2%.

D. Additional Conductor Identification

1. In addition to the color-coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.
2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.
3. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.
4. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.
5. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.
6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.
7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.



8. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that specific conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle using nylon wire ties and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.
9. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

#### E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

#### F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.
2. Instrumentation cable shall be racked and bundled separate from AC wiring to maintain the required separation as follows:
  - a. 18 inches for 480/277 VAC wiring
  - b. 12 inches for 208/120 VAC wiring
  - c. 6 inches for 24 VAC wiring

#### G. Conductor Terminations

1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible

compression type lugs. Reference individual equipment Specification Sections as applicable for additional termination requirements.

2. For conductors with stranding other than Class B or C, a UL 486A Listed wire ferrule shall be installed prior to each conductor termination. Ferrules shall be suitable for the size of conductors and shall be made of a material that is compatible with the conductors. Ferrules shall be crimped on in accordance with the ferrule manufacturer's instructions.
3. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction box per the requirements of Section 26 05 33.16 – Boxes for Electrical Systems, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.
4. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
5. Shielded VFD cables shall be terminated with kits required by or recommended by the approved shielded VFD cable manufacturer. Termination kits shall be installed in strict accordance with the shielded VFD cable manufacturer's and termination kit manufacturer's instructions. Where disconnect switches are shown on the Drawings to be installed on circuits utilizing shielded VFD cables, the installation shall be coordinated and executed as specified in Specification Section 26 28 16.16 – Enclosed Switches.
6. To minimize oxidation and corrosion, selected wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for electrical connections. The compound shall be Penetrox E for copper-to-copper connections, and Penetrox A for all other connections, as manufactured by Burndy Electrical, or equal. The joint compound shall be used in the following installations:
  - a. Termination of aluminum conductors, where aluminum conductors are specifically allowed by the Engineer.
  - b. Terminations in all Class I and Class II, Division 1 and 2 hazardous areas.

7. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

#### H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the workday for which the cable is removed from the protected storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

#### I. Circuit Log

1. The Contractor shall maintain a written log of installed circuit lengths for all single-phase and three-phase power circuits operating at 208VAC or greater. The log shall be organized in a tabular format, recording the following items for each circuit:
  - a. Circuit ID or Conduit ID(s) as shown on the Drawings.
  - b. From (originating equipment).
  - c. To (terminating equipment).
  - d. Conductor sizes and counts.
  - e. Conductor length.

### 3.02 TESTING

- A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:

1. Shop Test
  - a. Wires and cables shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.

## 2. Field Tests

- a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be “test light” or “buzzer” style.
- b. After installation, wires and cables shall be tested for insulation resistance levels between conductors of the same circuit and between conductor and ground as follows:
  - 1) For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute. Resistance shall be no less than 100 Megohms.
  - 2) Instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter or approved equal. The resistance value shall be 200 Megohms or greater.
  - 3) Insulation resistance testing is not required for power and control cables smaller than #8 AWG.
- c. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.
- d. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.
- e. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.



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Miscellaneous Information:

**Exhibit A**  
**Test Data – Megohms**  
**Test No. \_\_\_\_**

Part Tested:	Test Performed: _____ Hours/Days: _____ After Shutdown: _____
Grounding Time:	Dry Bulb Temperature: _____ Wet Bulb Temperature: _____
Test Voltage:	Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____

Megohmmeter:    Serial Number: \_\_\_\_\_    Range: \_\_\_\_\_  
                          Voltage: \_\_\_\_\_    Calibration Date: \_\_\_\_\_

Test Connections	To Line	To Line	To Line	Test Connections	To Line	To Line	To Line
	To Earth	To Earth	To Earth		To Earth	To Earth	To Earth
	To Ground	To Ground	To Ground		To Ground	To Ground	To Ground
1/4 Minute				5 Minutes			
1/2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minute Ratio			

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Remarks:

**END OF SECTION**



**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install grounding systems complete in accordance with the requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, building structural steel columns shall be permanently and effectively grounded.
- D. Reference Section 26 05 00 – Basic Electrical Requirements

**1.02 CODES AND STANDARDS**

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
    - a. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
    - b. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment.
  - 2. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 3. Underwriters Laboratories (UL):
    - a. UL 467 – Grounding and Bonding Equipment.

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of certified field tests.
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

### **2.02 FITTINGS**

- A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 Listed.

### **2.03 EQUIPMENT GROUNDING CONDUCTORS**

- A. An insulated equipment grounding conductor, which shall be separate from the electrical system grounded (neutral) conductor, shall be furnished and installed for all circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.

### **2.04 EQUIPMENT GROUNDS**

- A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.
- B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds, and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

### **2.05 GROUND BARS**

- A. Ground bars shall be furnished and installed where indicated on the Drawings and where required in the Specifications. Ground bars shall be tin-plated copper, 1/4-inch thick (minimum) with hole pairs spaced for NEMA 2-hole cable termination lugs. The number of hole pairs shall be as required for the number of cables terminated, plus four (4) spares (minimum). Ground bars shall be provided with insulated mounting hardware.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.
- B. Raceways
  - 1. Conduit which enters equipment such as switchgear, switchboards, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
1. Witnessed Shop Tests
    - a. None required.
  2. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.
    - b. Fall of potential tests shall be performed on the ground grid per IEEE 81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.
    - c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

**END OF SECTION**

**SECTION 26 05 29**  
**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install structural supports for mounting and installing all conduits, electrical equipment, lighting, alarm systems, instrumentation, and control and communications equipment furnished under this Contract.
- B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.
- C. Support design for all nonstructural electrical components (e.g., conduit and other raceways, freestanding equipment, etc.) shall be provided in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.
- D. Reference Specification Section 26 05 00 – Basic Electrical Requirements.

**1.02 CODES AND STANDARDS**

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American Society for Testing and Materials (ASTM):
    - a. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
    - b. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
    - c. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - d. ASTM A276 – Standard Specification for Steel Bars and Shapes.
    - e. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts.

2. National Fire Protection Association (NFPA):
  - a. NFPA 70 – National Electrical Code (NEC).

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  1. Shop drawings
  2. Structural support calculations and designs in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  1. Product data sheets.
  2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

### **2.02 MATERIALS**

- A. Support channel shall be 1-5/8" by 1-5/8" minimum, with 12-gauge material thickness.

- B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

<b>Area Designation</b>	<b>Material of Construction</b>
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Hot Dipped Galvanized Steel
Indoor Dry Non-process Area	Hot Dipped Galvanized Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

- C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

<b>Area Designation</b>	<b>Material of Construction</b>
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Type 304 Stainless Steel
Indoor Dry Non-process Area	Type 304 Stainless Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Concrete or Masonry Inserts
1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.
  2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.

3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

#### B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.
2. Unless otherwise indicated on the Drawings or in the Specifications, guards/handrails shall not be utilized as supports for electrical equipment, devices, or appurtenances. Guards/handrails shall not be cut, drilled, or otherwise modified in order to accommodate electrical supports without written approval from the Engineer.
3. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars, where possible, to facilitate removal of ceiling panels.
4. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
5. Equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.
6. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.
7. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.
8. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; Contractor shall submit design details to the Engineer for acceptance before proceeding with the fabrication.



9. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.
  10. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.
  11. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.
    - a. A quantity of twelve (12) or more conduits trade size 1" and smaller are proposed for a conduit support rack.
    - b. A quantity of eight (8) or more conduits trade sizes 1 1/2" to 2 1/2" are proposed for a conduit support rack.
    - c. A quantity of four (4) or more conduits trade sizes 3" and larger are proposed for a conduit support rack.
  12. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple conduits are installed exposed together, support channel and conduit clamps shall be used.
- C. Equipment, boxes, and enclosures which are factory-constructed with integral mounting provisions (such as brackets, mounting feet, bolt holes, etc.) shall be installed/supported utilizing those mounting provisions. Equipment, boxes and enclosures shall not be field-modified by any means which compromises the UL Listing or NEMA rating of the enclosure/assembly.

## END OF SECTION

**SECTION 26 05 33.13**  
**CONDUIT FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install conduits, conduit fittings, and appurtenances to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Reference Specification Section 26 05 00 – Basic Electrical Requirements.
- C. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Specification Section 26 05 29 – Hangers and Supports for Electrical Systems, for these requirements.

**1.02 CODES AND STANDARDS**

- A. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Conduits, conduit fittings, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)
    - a. ANSI/ASME B1.20.1 – Pipe Threads, General Purpose.
    - b. ANSI C80.1 – Electrical Rigid Steel Conduit.
    - c. ANSI C80.3 – Steel Electrical Metallic Tubing.
    - d. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
  - 2. National Electrical Contractors Association (NECA):
    - a. NECA 1 – Standard for Good Workmanship in Electrical Construction.
  - 3. National Electrical Manufacturer's Association (NEMA):
    - a. NEMA FB 2.40 – Installation Guidelines for Expansion and Expansion/Deflection Fittings.

- b. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit.
  - c. NEMA RV-3 – Application and Installation Guidelines for Flexible and Liquid-tight Flexible Metal and Nonmetallic Conduits.
  - d. NEMA TC-2 – Electrical PVC Conduit.
  - e. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
4. National Fire Protection Association (NFPA):
- a. NFPA 70 – National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
- a. UL 1 – Standard for Flexible Metal Conduit.
  - b. UL 6 – Electrical Rigid Metal Conduit-Steel.
  - c. UL 360 – Standard for Liquid-tight Flexible Metal Conduit.
  - d. UL 467 – Grounding and Bonding Equipment.
  - e. UL 514B – Conduit, Tubing, and Cable Fittings.
  - f. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings.
  - g. UL 797 – Electrical Metallic Tubing-Steel.
  - h. UL 1479 – Standard for Fire Tests of Penetration Fire Stops.
  - i. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit.
6. Others:
- a. American Concrete Institute (ACI): ACI 318 – Building Code Requirements for Structural Concrete.

### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
- 1. Shop Drawings
- B. Each submittal shall be identified by the applicable Specification Section.

#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Conduit identification methods and materials.
  - 2. Product data sheets for conduits, fittings, and miscellaneous associated materials.
    - a. The product data sheets for conduits and fittings for up to three (3) manufacturers for each type of conduit specified herein will be reviewed if they are submitted at the same time under the same submittal cover for simultaneous review.
    - b. Despite the number of manufacturers that may be approved, only one manufacturer of PVC coated rigid metal conduit will be permitted to be installed on this project in accordance with the requirements set forth in Part 3 herein.
  - 3. Manufacturer's Warranty Statement for PVC coated rigid metal conduit.
  - 4. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

#### 1.05 DEFINITIONS

- A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:
  - 1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.
  - 2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Also, conduits that carry fiber optic cables between devices and/or equipment.
  - 3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment. Conduits that carry Category 5e or Category 6 unshielded twisted-pair cables.

- B. Conduit categories are indicated on the Drawings by the leading letter of the conduit tag. Conduit tag leading letters are defined as follows:
1. P – Power Conduit
  2. C – Control Conduit
  3. I – Instrumentation Conduit

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses, and installation requirements of these conduits and conduit fittings.
- B. All metallic conduit fittings shall be UL 514B and UL 467 Listed and constructed in accordance with ANSI FB 1. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.
- C. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.
- D. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.
- E. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to  $\frac{3}{4}$  inch of expansion/contraction along the axis of the conduit as well as up to  $\frac{3}{4}$  inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by Type 304 stainless steel clamps.
- F. Conduit seals shall either be Listed and Labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.
- G. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.
- H. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

## 2.02 RIGID GALVANIZED STEEL (RGS) CONDUIT AND ASSOCIATED FITTINGS

### A. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

### B. Conduit Bodies for use with Rigid Galvanized Steel

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for all other areas shall be provided with covers that are affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

### C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

### D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

### E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of Type 316 stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.
3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

## 2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.
2. Conduit body shall be provided with cover that is affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

#### E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.
3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

### **2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS**

#### A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.
2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.
3. PVC coated conduit and associated PVC coated fittings shall be Ocal-Blue by ABB, Plasti-Bond by Robroy Industries, or Perma-Cote by Robroy Industries, no substitutions.
4. PVC coated conduit and associated PVC coated fittings shall be provided with a 5-year non-prorated warranty covering manufacturing defects and improper installation by the Contractor.

#### B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.



3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN 1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by Type 304 stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

**G. Conduit Termination Fittings for Use with PVC Coated Rigid Galvanized Steel Conduit**

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

**2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS****A. Conduit**

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.
2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed. Conduits shall be Listed for and marked with maximum temperature ratings as follows:
  - a. 105 degrees C dry, 60 degrees C wet for all conduit installed against or within 2 inches of equipment capable of having a surface temperature of 80 degrees C or greater (e.g., blowers, incinerators, etc.)
  - b. 80 degrees C dry, 60 degrees C wet for all other locations

**B. Conduit Termination Fittings for use with LFMC**

1. Conduit termination fittings shall be constructed of either Type 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.
2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic

insulated throat and shall be watertight when assembled to the conduit and equipment.

## **2.06 LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS**

### **A. Conduit**

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC), fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1660 Listed and be Type LFNC-B.

### **B. Conduit Termination Fittings for use with LFNC**

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

## **2.07 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS**

### **A. Conduit**

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

### **B. Conduit Termination Fittings for use with FMC**

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-style connection to the associated conduit.

## **2.08 ELECTRICAL METALLIC TUBING (EMT) AND ASSOCIATED FITTINGS**

### **A. Conduit**

1. Conduit shall be hot dipped galvanized on the inside and outside and made of cold-rolled steel tubing. Conduit shall be manufactured in accordance with C80.3 and shall be UL 797 Listed.

### **B. Conduit Bodies for use with EMT**

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies shall be provided with galvanized sheet steel covers that are affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Nipples for use with EMT

1. Couplings and nipples shall have threaded compression connectors with associated gland and shall be constructed of electro-galvanized steel. Fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable. Couplings and nipples shall be rain-tight and have a plastic insulated throat.

D. Conduit Expansion and Deflection Fittings for use with EMT

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Termination Fittings for use with EMT

1. Conduit termination fittings shall be constructed of electro-galvanized steel and have a plastic insulated throat. Termination fittings shall have a threaded compression connector with associated gland on one end and external threads on the other end. Termination fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts shall have integral bonding screw where required for proper bonding.

## 2.09 CONDUIT BENDS

- A. Rigid conduit bends, both factory-fabricated and field-fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

B. Conduit bend radii for standard radius bends shall be no less than as follows:

<b>Trade Size (inches)</b>	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
<b>Min. Radius (inches)</b>	4-1/2	5-3/4	7-1/4	8-1/4	9-1/2	10-1/2	13	15	16	24	30

C. Conduit bend radii for long radius bends shall be no less than as follows:

<b>Trade Size (inches)</b>	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
<b>Min. Radius (inches)</b>	N/A	12	18	24	30	30	36	36	48	48	60

**2.10 MISCELLANEOUS**

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:
  - a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.
  - b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors.
  - c. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.
2. See Part 3 herein for the specific application of the conduit periphery sealing requirements above that are to be used based on what the conduit will be penetrating.

B. Primer and Cement

1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer’s recommended cement that is labeled Low VOC.

C. Galvanizing Compounds

1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.

#### D. Conduit Interior Sealing

1. For all conduits that have cables inside, the sealing of the inside of the conduits against water ingress shall be achieved through the use of one of the following:
  - a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.
  - b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Rayflate by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.
  - c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed by two Type 304 stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.
2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.
3. For conduits identified as spares, the sealing of the inside of the conduit against water ingress shall be achieved by using appropriately sized rubber expanding-style conduit plugs.

#### E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, ½-inch wide, with a minimum tensile strength of 1250 lbs. In addition, pull ropes for conduits that are installed concealed shall also have a 22-AWG (minimum) tin-plated copper conductor woven in to make the rope detectable.
2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull and shall be made of a non-metallic material.

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

- A. All conduit and associated fittings and appurtenances shall be installed in accordance with NECA 1.
- B. Minimum trade size for all rigid conduits shall be 1 inch if any portion of the conduit is installed in a ductbank and 3/4 inch for all other applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.
- C. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.
- D. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.
- E. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.
- F. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.
- G. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be 3/4 inch per foot tapered threads in accordance with ANSI B1.20.1.
- H. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.
- I. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.
- J. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:

Installation Scenario	Clearance
Parallel to conduits with conductors energized at 480V or above	18 inches
Parallel to conduits with conductors energized at 240V and below	12 inches
At right angles to conductors energized at 480V and below	6 inches
At right angles to conductors energized at voltages above 480V	12 inches

- K. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.
- L. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.
- M. Conduits shall not penetrate the floors or walls inside liquid spill containment areas without specific written authorization from the Engineer.
- N. Conduits shall only penetrate the walls of liquid-holding tanks or basins above the maximum liquid elevation. Conduits shall not penetrate walls below this elevation.
- O. Conduits that terminate at roof mounted equipment shall be installed through the roof curb for the associated equipment to avoid additional roof penetrations wherever possible. Conduits that are installed horizontally on roof surfaces shall be supported by roof blocks that do not impact the roof manufacturer's warranty and shall be installed at least 7/8 inch above the roof surface to avoid the need to further de-rate the conductors inside.
- P. In no case shall conduit be supported or fastened to another pipe or be installed in a manner that would prevent the removal of other pipes for repairs. Spring steel fasteners may only be used to affix conduits containing lighting branch circuits within EMT conduits to structural steel members.
- Q. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.
- R. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.
- S. If multiple manufacturers of PVC coated conduit and conduit fittings are reviewed and approved for use by the Engineer, only one manufacturer shall be permitted to be used on the project throughout the entirety of the project. Consistency of a single manufacturer is critical to ensure proper fit and alignment, and to maintain the



manufacturer’s warranty throughout the PVC coated system. Use of multiple manufacturers’ PVC coated products is not acceptable.

**3.02 CONDUIT USES AND APPLICATIONS**

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

**Rigid Conduit for Non-Hazardous Areas**

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry process areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor Type 1 chemical storage/transfer areas	Schedule 80 rigid non-metallic PVC conduit	Same as Power and Control
Exposed in indoor Type 2 chemical storage/transfer areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed in outdoor areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed within pre-fabricated electrical equipment center buildings	Electrical Metallic Tubing	Same as Power and Control
Concealed within underground concrete-encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Direct-buried conduits (where specifically permitted)	PVC coated rigid galvanized steel conduit	PVC coated rigid galvanized steel conduit
Concealed within non-elevated (i.e., "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within elevated concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

**Rigid Conduit for Non-Hazardous Areas**

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Concealed below concrete slabs (within earth or fill material)	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within concrete walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within CMU walls	Schedule 40 rigid non-metallic PVC conduit or Electrical Metallic Tubing	Rigid galvanized steel conduit
Concealed above suspended ceilings	Electrical Metallic Tubing	Same as Power and Control
Concealed within interior walls constructed of metal studs and gypsum wall board	Electrical Metallic Tubing	Same as Power and Control
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit (Reference Detail E-26-0102)	PVC coated rigid galvanized steel conduit	Same as Power and Control

2. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be PVC coated rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

**B. Conduit Bends**

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:
  - a. All 90-degree bends or combinations of adjacent bends that form a 90-degree bend where concealed within concrete or below a concrete slab shall be rigid galvanized steel.
2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends

shall have minimum bending radii in accordance with the associated tables in Part 2 herein.

3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.
4. Long radius bends shall be furnished and installed for the following specific applications, all other bends shall be standard radius:
  - a. All conduits containing shielded VFD cable.
  - b. Where specifically indicated on the Drawings.

#### C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:
  - a. Connections to motors and engine-generator sets (and similar vibrating equipment)
  - b. Connections to solenoid valves and limit switches
  - c. Connections to lighting fixtures installed in suspended ceilings
  - d. Connections to lighting transformers and combination power units
  - e. Connections to pre-fabricated equipment skids
  - f. Connections to HVAC equipment
  - g. Connections to instrument transmitters and elements
  - h. Where specifically indicated in the Standard Details
2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.
3. Unless otherwise specified herein, flexible conduits shall be installed in accordance with the Installation Guidelines published within NEMA RV-3.
4. Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

**Flexible Conduit for Non-Hazardous Areas**

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Flexible metal conduit	Same as Power and Control
Exposed in indoor Type 1 chemical storage/transfer areas	Liquid-tight flexible non-metallic conduit	Same as Power and Control
Exposed in indoor Type 2 chemical storage/transfer areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in outdoor areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings (all indoor areas)	Same material as exposed conduit in same area	Same as Power and Control

**3.03 CONDUIT FITTING USES AND APPLICATIONS**

A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.
2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.
2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies

shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

#### C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than  $\frac{1}{4}$  inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

#### D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.
2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.
3. Unless otherwise specified herein, conduit expansion and deflection fittings shall be installed in accordance with the Installation Guidelines published within NEMA FB 2.40.

#### E. Conduit Seals

1. Conduit seals shall be installed as required by the NEC. In addition, conduit seals shall also be furnished and installed as follows:

#### F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.
2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the interior locknut.

3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

### **3.04 MISCELLANEOUS**

#### **A. Conduit Periphery Sealing**

1. Unless otherwise indicated on the Drawings, below-grade conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein.
2. Unless otherwise indicated on the Drawings, all conduit penetrations through interior walls and floors and above-grade exterior walls shall be sealed using conduit sleeves and caulk as specified in Part 2 herein. Alternatively, where concrete or masonry walls/floors are penetrated, mortar may be used to seal around the conduit periphery for conduit penetrations through interior walls and floors and above-grade exterior walls.
3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

#### **B. Conduit Interior Sealing**

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.
2. Conduit interior sealing shall not be installed until conductors inside are tested and test results are deemed acceptable by the Engineer. Conduit interior sealing shall be installed prior to energization of the conductors inside.

### **3.05 CONDUIT IDENTIFICATION**

- A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
  2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g., TO: DB-EF-1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g., FROM: MCC-S1). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.
  3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18-point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24-point font.
  4. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
  5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system using thermal transfer technology. Handwritten labels are not acceptable.
  6. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.
- B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:
1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
  2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
- C. Conduits for lighting and receptacle circuits shall not require identification.
- D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

**3.06 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

**3.07 TRAINING OF INSTALLATION PERSONNEL**

- A. All Contractor personnel that install PVC coated rigid metal conduit shall be trained by the PVC coated conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit or shall be trained/re-trained as required prior to commencement of conduit installation.

**END OF SECTION**



**SECTION 26 05 33.16**  
**BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install all pull boxes, junction boxes, and outlet boxes as specified herein, indicated on the Drawings, and as required. Requirements for other boxes and enclosures are not necessarily included in this Section. Reference each specific equipment specification section for requirements related to that equipment's respective enclosure.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 33.13 – Conduit for Electrical Systems
  - 3. Section 26 05 53 – Identification for Electrical Systems

**1.02 CODES AND STANDARDS**

- A. All boxes shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Boxes shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. National Electrical Manufacturers Association (NEMA):
    - a. NEMA 250 – Enclosures for Electrical Equipment.
  - 2. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 3. Underwriters Laboratories (UL):
    - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.
    - b. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations.
    - c. UL 514A – Metallic Outlet Boxes.

- d. UL 514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:
  1. Shop Drawings
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  1. Product data sheets for boxes, terminal strips, and all accessories

### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.
- B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

### **1.06 IDENTIFICATION**

- A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g., PPB-XXX, CJB-YYY) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

### **2.02 PULL AND JUNCTION BOXES**

#### A. General

- 1. All pull and junction boxes shall be UL Listed and Labeled.
- 2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.
- 3. Pull and junction boxes mounted embedded in concrete shall be UL Listed for embedment.
- 4. Where metallic boxes are used, they shall be of all welded construction. Tack welded boxes are not acceptable.

#### B. Pull Boxes

- 1. Metallic pull boxes in non-hazardous locations shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.
- 2. Non-metallic pull boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., “flip”) latches. Latch material of construction shall match the box material, and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.
- 3. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.

4. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.
5. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
  - a. Power wiring
  - b. AC control wiring
  - c. DC control wiring
  - d. Instrumentation wiring

#### C. Junction Boxes

1. Metallic junction boxes in non-hazardous locations shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.
2. Non-metallic junction boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., "flip") latches. Latch material of construction shall match the box material and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.
3. Barriers shall be provided in junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
  - a. Power wiring
  - b. AC control wiring
  - c. DC control wiring
  - d. Instrumentation wiring

4. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.
5. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting of the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.
6. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

**D. Enclosure Types and Materials**

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or PVC
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

**2.03 OUTLET BOXES**

**A. General**

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 26 27 26 – Wiring Devices for outlet box trim

requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

**B. Surface Mount Outlet Boxes**

1. Outlet boxes shall be the deep type, no less than 2.5 inches deep.
2. Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.
3. In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, PVC Coated Steel
Indoor Dry Process Area	NEMA 1, Cast Aluminum
Indoor Dry Non-process Area	NEMA 1, Cast Aluminum
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, PVC
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, PVC Coated Steel
All Outdoor Areas	NEMA 4X, Cast Aluminum PVC Coated Steel

4. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

**C. Flush Mount Outlet Boxes**

1. Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL Listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.
2. Outlet boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.
3. Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.

4. Outlet boxes mounted cast into concrete shall be concrete tight and made of galvanized steel or PVC.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

#### **A. Pull and Junction Boxes**

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.
4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Reference Section 26 05 33.13 – Conduit for Electrical Systems for conduit hub requirements.
5. Pull and junction boxes may be installed flush mounted in gypsum, concrete, or CMU walls where appropriate provided that covers are easily removed or opened.
6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

#### **B. Outlet Boxes**

1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.

4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in type 1 or 2 chemical storage/transfer areas.
5. Depending on the type of wiring device to be installed in the outlet box, mounting heights from the finished floor or finished grade (as applicable) to the center of the box shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):
  - a. Light switches, 48 inches
  - b. Receptacles in indoor dry process/non-process areas, 18 inches
  - c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 42 inches in open areas, or 6 inches (minimum) above adjacent surfaces (e.g., countertops, tables, etc.) where applicable
  - d. Receptacles in outdoor locations, 26 inches
  - e. Flush mounted outlet boxes in CMU walls shall be adjusted to a slightly greater height than required above to align the center of the box with the center of the CMU block.
6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

**END OF SECTION**



**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All electrical equipment shall be identified in the manner described, or in an equally approved manner.
- B. The types of electrical identification specified in this Section include, but are not limited to, the following:
  - 1. Operational instructions and warnings.
  - 2. Danger signs.
  - 3. Equipment/system identification signs.
  - 4. Nameplates.

**1.02 SIGNS**

- A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

**1.03 LETTERING AND GRAPHICS**

- A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

**1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

## **1.05 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

### **2.02 NAMEPLATES**

- A. Nameplates shall be engraved, high pressure plastic laminate, white foreground with black lettering.
- B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or Engineer approved equal.

### **2.03 HIGH VOLTAGE SIGNS**

- A. Standard "DANGER" signs shall be of baked enamel finish on 20 gauge steel; of standard red, black, and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

### **2.04 CONDUIT IDENTIFICATION**

- A. Conduit identification shall be as specified in Section 26 05 33.13 – Conduit for Electrical Systems.

## **2.05 WIRE AND CABLE IDENTIFICATION**

- A. Field installed wire and cable identification shall be as specified in Section 26 05 19 – Low Voltage Conductors and Cable.
- B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly convey the conductor identification means used at that piece of equipment (i.e., Phase A=Brown, Phase B=Orange, C = Yellow).
- C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective Section.

## **2.06 BOX IDENTIFICATION**

- A. Pull, junction and device box identification shall be as specified in Section 26 05 33.16 – Boxes for Electrical Systems.

## **PART 3 – EXECUTION**

### **3.01 NAMEPLATES**

- A. Nameplates shall be attached to the equipment enclosures with two (2) stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

### **3.02 OPERATIONAL IDENTIFICATION AND WARNINGS**

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

### **3.03 POWER SOURCE IDENTIFICATION**

- A. After installation of all field equipment (e.g., valves, motors, fans, unit heaters, instruments, etc.) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC

number, panelboard, etc.), circuit number, conduit number from schedule and voltage/phase.

- B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.
- C. Nameplates shall be as specified herein.

**END OF SECTION**

**SECTION 26 09 16**  
**ELECTRIC CONTROLS AND RELAYS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.
- B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and Labeled in compliance with IEC standards is not acceptable.
- C. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 53 – Identification for Electrical Systems

**1.02 CODES AND STANDARDS**

- A. Products specified herein shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. National Electrical Manufacturers Association (NEMA):
    - a. NEMA 250 – Enclosures for Electrical Equipment.
  - 2. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 3. Underwriters Laboratories (UL):
    - a. UL 508A – Standard for Industrial Control Panels.

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings

## 2. Spare Parts List

- B. Each submittal shall be identified by the applicable Specification Section.

### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

### 1.05 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. In addition to the manufacturer recommended spare parts, the following spare parts shall be provided for the local control stations:
  - 1. One (1) contact block of each type furnished on the project
  - 2. One (1) indicating light lens of each color furnished on the project
  - 3. One (1) LED lamp of each color furnished on the project
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

## PART 2 – PRODUCTS

### 2.01 CONTROL COMPONENTS

- A. Manufacturers

1. Control components shall be manufactured by Eaton, The Square D Company, GE by ABB, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

## B. Pilot Devices

### 1. General

- a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (e.g., HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc.).
- b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.
- c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.
- d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

### 2. Pushbuttons

- a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.
- b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
- c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

### 3. Selector Switches

- a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as

required. Handles shall be the extended type that provide a greater surface area for operation.

- b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
- c. Where indicated in the Drawings or Specifications, provide spring return positions.
- d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights

- a. Indicating lights shall be LED type, with the proper voltage rating to suit the application, and push-to-test feature.
- b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:

Color	Designation
Red	"Run", "On", "Open"
Green	"Off", "Closed"
Amber	"Alarm", "Fail"
White	"Control Power On"

5. Emergency Stop and Tagline Switches

- a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.
- b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.



- c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

## C. Relays and Timers

### 1. General

- a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.
- b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.
- c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

### 2. Control and Pilot Relays

- a. Relays shall have a clear or translucent housing that allows the contacts to be visually inspected without disassembly.
- b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
- c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.

### 3. Time Delay Relays

- a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.
- b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
- c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.

- d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.
- 4. Elapsed Time Meters
  - a. Elapsed time meters shall be non-resettable type with no less than a four (4) digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.
- D. Control Terminal Blocks
  - 1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 – #8 AWG.
  - 2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (e.g., 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.
  - 3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

**2.02 LOCAL CONTROL STATIONS**

- A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.
- B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.
- C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Die Cast Zinc

Area Designation	Enclosure Type and Material
Indoor Dry Non-process Area	NEMA 12, Die Cast Zinc
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or Thermoplastic Polyester
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

- D. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.
- E. Local control stations for use in non-hazardous locations shall be UL-508 Listed.
- F. Provide a nameplate on each local control station in accordance with Section 26 05 53 – Identification for Electrical Systems. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words “LOCAL CONTROL STATION”.

**PART 3 – EXECUTION**

**3.01 INSTALLATION**

- A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- B. Local control stations shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the enclosure, at the equipment height where appropriate and permitted by the NEC, or as shown otherwise on the Drawings.
- C. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.
- D. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The

device shall be bonded to the equipment enclosure with an insulated green bonding conductor.

- E. Local control station covers shall be bonded to the local control station enclosure with an insulated green bonding conductor.
- F. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.
- G. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

**END OF SECTION**

**SECTION 26 22 00**  
**LOW VOLTAGE TRANSFORMERS**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, test, and place in satisfactory operation transformers for power and lighting distribution systems as specified herein, as indicated on the Drawings, and as required to complete the electrical installations.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 53 – Identification for Electrical Systems
- C. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Transformers shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
    - a. ANSI/IEEE C57.12.01 – Standard for General Requirements for Dry -Type Distribution and Power Transformers.
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. NEMA ST 20 – Dry Type Transformers for General Applications.
  - 3. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 4. Underwriters Laboratories (UL):

- a. UL 1561 – Dry-Type General Purpose and Power Transformers.
5. U.S. Department of Energy 2016 Efficiency Standards

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Division 01, the Contractor shall obtain from the equipment manufacturer and submit the following:
1. Shop Drawings.
  2. Operation and Maintenance Manuals.
  3. Spare Parts List.
  4. Reports of Certified Shop Field Tests.
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein, and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
1. Product data sheets.
  2. Drawings showing clearly marked dimensions and weight for each transformer.
  3. Sample equipment nameplate diagram.
- D. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., TX-LP-DB).
- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

**1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.

**1.06 SPARE PARTS**

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- A. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

**1.07 IDENTIFICATION**

- A. Each transformer shall be identified with the equipment item number indicated on the Contract Drawings and the accepted Shop Drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

**PART 2 – PRODUCTS****2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Dry type distribution transformers shall be Energy Star compliant and manufactured by the Square D Company, GE by ABB, Eaton, or Siemens Energy and Automation, Inc.

**2.02 DRY TYPE TRANSFORMERS**

- A. Furnish and install single-phase and three-phase general purpose, dry-type transformers, as specified herein and indicated on the Drawings. The transformers shall be 60 Hz, self-cooled, quiet-design insulated of the two-winding type.
- B. The transformers shall be UL 1561 Listed.
- C. The primary windings shall be rated 480 VAC for use on 3-phase systems and connected delta unless indicated otherwise on the Drawings. KVA ratings shall be as shown on the Drawings. Furnish transformers with two 2-1/2% primary taps above, and four 2-1/2% primary taps below rated voltage for transformers 15 KVA and above, and

two 2-1/2% primary taps above, and two 2-1/2% primary taps below rated voltage for transformers less than 15 kVA. All taps shall be full capacity rated.

- D. The ratings of the secondary windings shall be as indicated on the Drawings.
- E. Transformers shall be designed for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in ANSI/IEEE C57.96. This performance shall be obtainable without exceeding 150 degrees Celsius average temperature rise by resistance or 180 degrees Celsius hot spot temperature rise in a 40 degrees Celsius maximum ambient and 30 degrees Celsius average ambient. The maximum coil hot spot temperature shall not exceed 220 degrees Celsius. All insulating materials shall be flame retardant and shall not support combustion as defined in ASTM Standard Test Method D 635. All insulating materials shall be in accordance with NEMA ST 20 Standard for a 220 degrees Celsius UL component recognized insulation system.
- F. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with non-hygroscopic, thermosetting varnish.
- G. All cores are to be constructed of high grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be tightly clamped and compressed with structural steel angles. The completed core and coil shall then be bolted to the base by means of vibration-absorbing mounts to minimize sound transmission. There shall be no metal-to-metal contact between the core and coil assembly and the enclosure.
- H. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees Celsius. Transformers shall be furnished with lugs of the size and quantity required and suitable for termination of the field wiring.
- I. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.
- J. Transformers shall have core and coil assemblies mounted on rubber isolation pads to minimize the sound levels. Transformers shall not exceed the sound levels listed in NEMA ST-20.
- K. Transformers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.



Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 3R, Painted Steel
Indoor Dry Process Area	NEMA 2, Painted Steel
Indoor Dry Non-Process Area	NEMA 2, Painted Steel
All Outdoor Areas	NEMA 3R, Painted Steel

The enclosure shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with a baked weather-resistant enamel using the manufacturer's standard painting process. Color shall be ANSI 49 or 61 grey.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. The transformers shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.
- B. Conduit routed to and from the transformer shall be arranged for easy removal of the transformer access covers.
- C. Where transformers 50 kVA and smaller are shown to be wall mounted, a transformer manufacturer supplied wall mounting kit shall be used. The lowest point of the wall mounting bracket shall be no lower than 7'-0" above the finished floor. Field fabricated mounting hardware is not acceptable unless reviewed and approved in writing by the Engineer.
- D. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  1. Certified Shop Tests
    - a. The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design.
    - b. As a minimum, the following tests shall be made on all transformers:

- 1) Ratio tests on the rated voltage connection and on all tap connections.
  - 2) Polarity and phase-relation tests on the rated voltage connection.
  - 3) Applied potential tests.
  - 4) Induced potential tests.
  - 5) No-load and excitation current at rated voltage on the rated voltage connection.
2. Field Tests
- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.
  - b. Insulation between windings shall be tested by 1000 VDC Megohmmeter for one (1) minute. Resistance value shall be no less than 100 Megaohms.

**END OF SECTION**

**SECTION 26 24 16**  
**PANELBOARDS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, test, and place in satisfactory operation panelboards as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles, and arrangements/locations conforming to the panelboard schedules shown on the Drawings.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 53 – Identification for Electrical Systems

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. National Electrical Contractors Association (NECA):
    - a. NECA 407 – Standards for Installing and Maintaining Panelboards.
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. NEMA PB 1 – Panelboards.
  - 3. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 4. Underwriters Laboratories (UL):
    - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.
    - b. UL 67 – Standard for Panelboards.

- c. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
- d. UL 943 – Ground Fault Circuit Interrupters.

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings.
  - 2. Spare Parts List.
  - 3. Operation and Maintenance Manuals.
  - 4. Reports of Field Tests.
- B. Each submittal shall be identified by the applicable Specification Section.

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.
  - 3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.
  - 4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., LP-1, etc.).

### **1.05 OPERATIONS AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01. The manuals shall include:

1. Instruction books and/or leaflets.
2. Recommended spare parts list.
3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

#### **1.06 SPARE PARTS**

- A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.
- A. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

#### **1.07 IDENTIFICATION**

- A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

### **PART 2 – PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. The Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. It is the intent of these specifications that the panelboards be produced by a single manufacturer who shall be responsible for matching all components and providing equipment which functions together as a system.
- C. Lighting and instrument panelboards, those identified with prefix “LP” and “IP” respectively on the Drawings, shall be the PRL1X or PRL2X Series by Eaton, NQ Series by Square D, GE by ABB equivalent, or Siemens Energy and Automation, Inc. equivalent.

#### **2.02 PANELBOARDS**

- A. General

1. Panelboards shall be dead-front type and shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards.
2. Where specified herein, indicated on the Drawings, or required, panelboards shall be rated for service entrance and bear a service entrance label.
3. Panelboards shall be equipped with a main circuit breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting as indicated on the Drawings.
4. Panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical for units rated 240VAC and below, and 42,000 amperes symmetrical for units rated above 240VAC, unless otherwise indicated on the Drawings.

#### B. Enclosures

1. Enclosures shall be UL 50 Listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI 49 or 61 gray. The enclosure shall have wiring gutters on the sides and shall be at least 5-3/4 inches deep. Wiring gutters shall be large enough to allow compliance with NEC minimum bending radius requirements for all cables to be terminated, including future cables sized for any spare circuit breakers that are shown on the Drawings.
2. All panelboards shall be provided with a dead front style trim. Additional trim requirements are as follows:
  - a. Distribution panelboards with enclosures that are rated other than NEMA 12 shall have hinged covers over each vertical wiring gutter to allow access to all branch mounted device terminations without removing the panel trim.
  - b. Power, lighting, and instrumentation panelboards with enclosures that are rated other than NEMA 12 shall be provided with a full height hinge where it is attached to the panelboard box. Trim shall be attached to the panelboard enclosure using concealed trim clamps. Resultant trim assembly shall allow work inside the enclosure without the need to remove the panel trim from the enclosure.
3. Panelboard trims shall include a door over the dead front area to provide access to the circuit breakers and other devices. The access door shall be fastened to the

trim with concealed hinges and be equipped with flush-type catches. Access doors exceeding 40 inches in height shall be equipped with a vertical bolt three-point locking mechanism, all other doors shall have a single-point mechanism. All locks shall be keyed alike.

4. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, number of wires, and bus ratings.

#### C. Bus Work

1. Where 3-wire bus is indicated on the Drawings, the panelboard shall be furnished with 3 phase busses and a ground bus. In addition, if a transformer with a grounded wye secondary is shown on the Drawings to be supplying a 3-wire panelboard, a neutral landing pad shall be furnished within the panelboard to provide a place to terminate the grounded conductor. Providing a 4-wire bus (3 phases plus neutral) for a 3-wire system is not acceptable.
2. Where a 4-wire bus is indicated on the Drawings, the panelboard shall be furnished with 3 phase busses, a neutral bus of equal ampacity to the phase bus, and a ground bus.
3. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel to provide full flexibility of circuit arrangement.
4. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
5. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
6. All bus shall be tin-plated copper and shall extend the entire useable length of the panelboard, including spaces.
7. Where required by the NEC, a bonding jumper, sized in accordance with the NEC, shall be installed between the panelboard ground bus and the neutral bus or neutral landing pad.

#### D. Circuit Breakers

1. Main and branch circuit breakers shall be bolt-on, UL 489 Listed molded-case type with trip ratings as indicated on the Drawings. Unless otherwise indicated, circuit breakers shall be manually operable, with automatic trip-free operation, and shall

provide inverse-time-limit overload and instantaneous short-circuit protection. All circuit breakers shall have quick-make, quick-break, toggle mechanisms for manual as well as automatic operation.

2. Main circuit breakers shall be individually mounted. Branch-mounted main circuit breakers are not acceptable unless specifically indicated on the Drawings. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location(s).
3. Tandem or half-size circuit breakers are not acceptable.
4. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. The number of poles and trip ratings shall be as indicated on the Drawings. Where a trip rating is not indicated on the Drawings, provide a 20A circuit breaker.
5. Circuit breakers for panelboards rated 240VAC and below shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating. Circuit breakers for panelboards rated above 240VAC shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.
6. Unless indicated otherwise on the Drawings, circuit breakers with smaller than 225-ampere frames shall be the thermal-magnetic type. Thermal and magnetic trip elements may be fixed or adjustable.
7. Where indicated on the Drawings, and for circuit breakers of 225-ampere frames and larger, circuit breakers shall have interchangeable electronic trip units (ETU) and adjustable trip elements and time delays. Provide electronic trip units with the adjustable functions indicated on the Drawings (e.g., Long, Short, Instantaneous, Ground, etc.).
8. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault circuit interrupters (i.e., GFI/GFCI) complete with "TEST" push button, and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Ground fault circuit interrupter style circuit breakers shall be UL 943 Listed. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.
9. Where indicated on the Drawings, circuit breakers shall be 100% rated.
10. Where indicated on the Drawings, main circuit breakers shall be provided with a shunt trip device to trip the breaker from a remote location by means of a trip coil energized from a separate circuit. A 120 VAC shunt trip shall be capable of



operating at 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

11. Where indicated on the Drawings, or as required, circuit breakers shall be provided with a padlockable hasp or handle padlock attachment (lock-off device) for padlocking in the "OFF" position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Where indicated on the Drawings, or as required, branch circuit breakers shall be provided with a similar attachment (lock-on device) for padlocking in the "ON" position for critical circuits (e.g., fire alarm control panel circuits) which must remain energized.

#### E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard (including both new panelboards and existing panelboards modified under this project). The Contractor shall maintain in each panelboard, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

### 2.03 SURGE PROTECTIVE DEVICES

- A. Surge protective devices (SPD) shall be provided either integral to the panelboard or as a separate unit external to the panelboard enclosure, as indicated on the Drawings. See Section 26 43 13 – Surge Protective Devices for SPD requirements.
- B. Integral SPDs shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. Panelboards shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.
- B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.

- C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.
- D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.
- E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.
- F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.
- G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  - 1. Field Tests
    - a. Prior to termination of any conductors to the circuit breakers, all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megohmmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.
    - b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

**END OF SECTION**

**SECTION 26 24 19**  
**LOW VOLTAGE MOTOR CONTROL CENTERS**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, test, and place in satisfactory operation, the motor control centers as specified herein and indicated on the Drawings.
- B. The Contractor shall obtain the motor control centers from one manufacturer who shall also manufacture the enclosure and major equipment components, which includes, but is not limited to, combination starters, variable frequency drives, circuit breakers, power monitoring equipment, and other components of the equipment assembly. Subcontracting of wiring is not acceptable.
- C. The motor control center shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.
- D. Reference Section 26 05 00 – Basic Electrical Requirements; Section 26 05 53 – Identification for Electrical Systems; Section 26 43 13 – Surge Protective Devices, and Section 26 09 16 – Electric Controls and Relays.

**1.02 CODES AND STANDARDS**

- A. The assemblies shall meet or exceed the requirements within the following standards for motor control centers:
  - 1. NEMA ICS-18
  - 2. UL845
- B. The motor control center shall be designed, manufactured, and tested in facilities registered to the following quality standards:
  - 1. ISO 9001

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.
2. Spare Parts List.
3. Proposed Testing Methods and Reports of Certified Shop and Field Tests.
4. Manufacturers Startup Certification
5. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable Specification Section.

#### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings for each motor control center shall include but not be limited to:
  1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
  2. Product data sheets.
  3. Example equipment nameplate data sheet.
  4. Approximate total shipping weight of each shipping split.
  5. Plan, front, and side view drawings, including overall dimensions of each motor control center. Identify shipping splits and show conduit stub-up area locations on the Drawings.

6. Internal schematic and point-to-point wiring diagrams of each motor control unit including variable frequency drives integrated into the motor control center. Standard wiring diagrams that are not custom created by the manufacturer for the motor control centers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. screw pump, backwash pumps) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.
  7. Complete single-line diagrams for each motor control center showing circuit breakers, motor circuit protectors, motor controllers, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete assembly. Indicate electrical ratings of equipment and devices on these single-line diagrams. Ratings include starter size and type, motor circuit protector continuous current rating, circuit breaker frame size and trip rating, motor horsepower and full load current, and similar information.
  8. Bill of material list for each motor control center and each motor control unit.
  9. Nameplate schedule for each motor control center.
  10. Manufacturer's installation instructions.
  11. Key interlock scheme drawing and sequence of operations.
  12. Manufacturer's Warranty Statement
  13. Table listing all motor loads connected to the motor control center. Table shall include the full load amps of the APPROVED motors. Final approval of MCC shop drawings cannot be given until all motor loads for MCC have been reviewed, approved, and shown in this table.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each motor control center unit of each motor control center. These final drawings shall be included in the O&M manuals.

**1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.

**1.06 SPARE PARTS**

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each motor control center:
1. One (1) set of fuses of each size provided
  2. One (1) starter coil and complete set of contacts for each size and type of starter provided
  3. One (1) relay of each type and size provided
  4. One (1) control power transformer of each size provided
  5. Two (2) lamps and lenses for indicating lights for each color provided
  6. One (1) indicating lamp socket for each type provided
  7. One (1) pilot device (e.g. pushbutton, selector switch, etc.) complete with contact blocks and legend plates for each type, size, and rating provided
  8. One (1) motor circuit protector for each type, size, and rating provided
  9. One (1) circuit breaker for each type, size, and rating provided (except main circuit breakers)
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Term such as "1 lot of packing material" are not acceptable.

- E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

## **1.07 IDENTIFICATION**

- A. Each motor control center shall be identified with the identification number indicated on the Drawings (e.g., MCC-S4, etc.). A nameplate shall be securely affixed in a conspicuous place on each motor control center. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

## **PART 2 – PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. It is the intent of these specifications that all components of the motor control center be provided by one manufacturer who shall have the sole responsibility of matching all components and providing equipment which functions together as a system. The manufacturer of the motor control center shall also be the manufacturer of the motor controllers. The use of third-party supply and assembly of these components is not acceptable.
- C. Motor control centers shall be intelligent Centerline 2100 utilizing DeviceNet communications as manufactured by Allen-Bradley, Eaton equivalent, General Electric equivalent, or the Square D Company equivalent.

### **2.02 MOTOR CONTROL CENTER**

- A. General
  - 1. The motor control centers shall be 600 VAC class suitable for operation on a three-phase, 60 Hz system. The motor control centers and their components shall conform to the requirements of applicable standards of NEMA Part ICS 2-322 and Underwriters' Laboratories, Inc. UL-845. Wiring shall be NEMA Class II, Type B. Each vertical section shall be a NEMA 1A (gasketed) industrial use enclosure unless otherwise specified or indicated on the Drawings.
  - 2. The enclosures shall be cleaned, primed, and finish coated in accordance with the manufacturer's standard process. The pre-treatment process shall be a zinc chromate primer followed by a "One Coat" paint process that is monitored to meet

the manufacturer's specifications for paint color, texture, thickness, and durability. Enclosure interior and exterior finish color shall be ANSI 49 (medium light gray). The color of the back panel/bucket located within the MCC enclosure shall be white.

3. The motor control centers shall be capable of withstanding the fault current available at its line terminals. Minimum bus bracing, withstand, and interrupting ratings are specified herein.
4. Unless otherwise specified or indicated on the Drawings, each vertical section shall be approximately 20 inches wide, and 90 inches high, 20 inches deep, and shall not contain more than six NEMA Size 1 starters. Motor control centers shown "back-to-back" on the Contract Drawings shall be complete motor control assemblies placed back-to-back in the location shown. Motor control center sections with common horizontal and/or vertical bus systems are unacceptable.
5. Continuous horizontal wiring troughs shall be provided at both the top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the motor control center. Each section shall be provided with a large, continuous, full height vertical wiring trough in the right side of each section. Each vertical wiring trough shall be furnished complete with tie bars for conductor support.
6. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105°C. Wire color coding shall be red for control and black for power. Wire numbers shall not be repeated in a motor control center.
7. Starter units shall contain the number of auxiliary contacts, unit-mounted pilot devices and indicating lights, control relays, elapsed time meters, and other devices as shown on the Drawings and required for the applications. A minimum of two (2) normally open (NO) and two (2) normally closed (NC) spare contacts shall be provided for each magnetic starter. These spare contacts shall be shown on the submittal wiring diagrams.
8. The motor control centers shall be furnished with warning signs to notify maintenance personnel of multiple sources of power within the motor control units.

#### B. Power

1. The motor control centers shall be supplied from a 480V, 3-phase, 3 or 4 wire as indicated on the Drawings, 60 Hz power source. The incoming power feeders shall



be sized as shown on the Drawings. All terminals for incoming and outgoing power cables shall be provided with compression lugs.

#### C. Bus

1. Power shall be distributed by means of a continuous, tin plated copper horizontal bus, rated as shown on the Drawings. The bus shall be braced for 65,000A rms symmetrical at 480V unless otherwise indicated on the Drawings. The horizontal bus shall be effectively isolated from all wiring troughs and other working areas. Vertical bus extensions shall be tin plated copper, isolated by rigid, glass-polyester moldings so as to be a separate self-supported assembly. Silver plated vertical bus may be provided if specifically accepted by the Engineer. Full height vertical bus shall be installed in all sections including those containing spare units and "prepared" spaces. No extra safety jacks or similar devices shall be required to obtain an essentially dead-front condition. Access shall be provided for inspection and maintenance from the front. Minimum horizontal bus rating shall be 600A. Minimum vertical bus rating shall be 300A.

#### D. Incoming Line Units

1. Each incoming line unit shall contain buswork and fittings as required with cable lugs for cables of sizes and quantities shown on the Drawings. Cable lugs shall be suitable for their respective conductors.

#### E. The Unit Compartments

1. Each unit compartment shall be provided with an individual front door hinged to the vertical structure. Each plug-in unit shall be supported and guided by a removable unit support pan, so that the unit rearrangement is easily accomplished. The rearrangement of the unit support pan from one location to the other shall be accomplished without use of tools. After insertion, each plug-in unit shall be held in place by at least one multi-turn latch, located at the front of the unit. The latch shall be located for front accessibility and installation convenience. An additional mechanical interlock shall be provided to prevent withdrawal of the unit from the stationary structure with the operating mechanism in the ON position.
2. The unit plug in power stabs shall be electromagnetically tin-plated copper to yield a low resistance connection and designed to tighten during heavy current surges and short circuits. The stab shall be backed by spring steel clips to provide and maintain a high pressure, two-point connection to the vertical bus. They shall be free floating and self-loading plug-in. Wiring from the unit disconnecting means to the plug-in stab shall be exposed at the rear of the unit. The power cable terminations at the plug-in stab shall be mounted in a two-piece, glass polyester support assembly. This support assembly shall provide a separate isolated

pathway for each phase, minimizing the probability of a unit fault condition reaching the power bus system.

3. NEMA Size 1 through Size 5 non-reversing starters shall be plug-in units. Size 1, 2, and 3 shall utilize stab assembly rated 100A. Stab assemblies for Size 4 and Size 5 starters shall be rated for the starters maximum output current rating.
4. An industrial, heavy-duty flange handle mechanism shall be supplied for the control of each disconnecting means. This mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position. The operator handles shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8 inch diameter shackle padlock.
5. The operator handle of all units shall be interlocked with the door units so that the disconnect means cannot be switched unless the door unit is closed. A means shall be provided for purposely defeating the interlock during maintenance or testing. This interlock shall also prevent opening the unit door unless the disconnecting means is in the off position. An externally operated def eater requiring the use of a screwdriver shall provide access to the unit without interrupting service.
6. The overload relays shall be resettable from the outside of the enclosure by means of an insulated bar or button.

#### F. Ground Bus

1. The horizontal ground bus shall be tin plated copper and located in the bottom horizontal wireway. The minimum size of the horizontal ground bus shall be ¼-inch x 1 inch (6.35mm x 25.4mm) or 33% of the phase bus ampacity, whichever is greater.
2. Compression lugs shall be mounted on the ground bus in each section, in the size and quantity as required for the termination of system and equipment grounding conductors.
3. The vertical ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. This ground bus, in combination with the unit ground bus stab, establishes unit grounding before the plug-in power stabs engage the power bus, and conversely, as the unit is withdrawn, grounding is maintained until after the plug-in power stabs are disengaged.

4. The vertical load ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. The vertical load ground bus assembly, comprised of the vertical load ground bus and the unit load ground bus connector, shall provide a termination point for the load equipment grounding conductor at the unit. This fixed connection shall not have to be removed when the unit is withdrawn from the motor control center.

#### G. Isolation and Insulation

1. Horizontal bus access covers and vertical bus covers shall isolate the energized buses to guard against the hazard of accidental contact. These covers shall be molded of a glass polyester material.
2. The horizontal bus shall be isolated from the top horizontal wireway by a grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.
3. The vertical bus cover shall provide unit plug-in openings which shall permit unit plug-in stab assemblies to pass through and engage the vertical bus. The unit plug-in openings shall be sized to minimize the probability of inadvertent contact with the vertical bus.
4. Isolation of unused stab openings shall be accomplished by use of a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.
5. All units shall be isolated from one another, above and below, by unit support pans or steel barriers, which can remain in place when the units are withdrawn.
6. Incoming line compartments shall be isolated from horizontal and vertical wireways by steel barriers.
7. A molded unit isolating barrier shall be provided to isolate the unit from the vertical wireway.

#### H. Combination Motor Control Units

1. Motor branch circuits shall be protected by a motor circuit protector (MCP).
2. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and

OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.

3. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.
4. The motor circuit protectors in combination with a contactor and overload relay shall have an interrupting rating that matches the motor control center short circuit rating at 480V.
5. Motor circuit protector's ratings, modifications, etc., shall be as specified herein and as indicated on the Drawings.
6. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

#### I. Motor Starters

1. Motor starters shall conform to NEMA Standard IC1 and shall be for across-the-line starting, unless otherwise indicated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment. The size of the starter shall be as required for the particular load. Minimum starter size shall be NEMA Size 1. Size 1 and 2 starters shall be completely drawout type, so that units may be withdrawn without disconnecting any wiring. Size 3 and 4 full-voltage, non-reversing starters shall be drawout type after disconnecting power leads only. Starters over three-space units high may be bolt-on type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in deadfront openings in vertical power bus.
2. A suitable control disconnect device(s) to comply with the requirements of the NEC shall be provided.
3. Magnetic starters and contactors shall be electromagnetic vertical or horizontal lift design with double break cadmium oxide silver contacts. Design shall meet or exceed the requirements of UL and NEMA Standards. Coils shall be hot molded construction to protect the coils from mechanical and environmental damage.
4. Each starter shall be able to accommodate a minimum of three (3) auxiliary contacts in addition to the hold-in contact.

5. If required, each starter shall be supplied with a three-pole, manual test and reset overload relay. The relay shall be an E3+ solid state overload relay as manufactured by Allen-Bradley. The relay shall meet the requirements specified in this Section.
6. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid-state equipment (e.g. programmable logic controller) wired as part of the control circuit.
7. The Contractor and motor control center manufacturer is advised to review the Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides. The minimum control power transformer VA requirements are shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.
  - a. Size 1-75 VA
  - b. Size 2-75 VA
  - c. Size 3-200 VA
  - d. Size 4-300 VA
  - e. Size 5-500 VA
8. DeviceNet Starter Auxiliary (DSA) modules shall be furnished and installed as specified herein and indicated on the Drawings. These modules shall be supplied with four (4) input points and two (2) output points. The output points shall provide direct control of motor starter coils up to NEMA Size 5. The output points shall also provide direct control of other electrical devices within the electrical ratings limits of the module.

#### J. Circuit Breakers

1. Where specified herein, indicated on the Drawings, or required, the main circuit breaker shall be rated for service entrance and bear a service entrance label.
2. Unless otherwise indicated, circuit breakers shall be manually operable and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous short-circuit protection.
3. Circuit breakers shall be molded case type, rated 480 VAC, 2 or 3 pole and have 100 ampere or larger frames. The interrupting rating shall match that of the motor control center short circuit rating at 480V.

4. Overload protection shall be provided on all poles with trip settings as indicated on the Drawings. Breakers of 225-ampere frames and larger shall have interchangeable trip units and adjustable magnetic trip elements.
5. Horizontally mounted operator handles for feeder circuit breaker units up to 225A are permissible if accepted in writing by the Engineer.
6. Where indicated on the Drawings, shunt trip devices shall be provided to trip a circuit from a remote location by means of a trip coil energized from a separate circuit. A 120V shunt trip shall be capable of operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

#### K. Terminal Blocks

1. Terminal blocks associated with removable units within the motor control center shall be provided as follows:
  - a. Terminal blocks shall be mounted within the unit insert and in the front for ease of accessibility.
  - b. Pull-apart style terminal block assemblies shall be provided. Terminal block assembly shall consist of a male and female component held together with captive screws. The terminal block assembly shall be designed to withstand the effects of vibration, yet able to be pulled apart without difficulty. The terminals of the assembly shall be recessed to isolate them from accidental contact. Terminal markings shall be provided for the purpose of identifying terminations. Terminal strips shall be suitable for use as a disconnecting means of foreign interlock voltages.
  - c. For starters Size 2 and smaller, terminate all starter wiring (power and control) and external field wiring on terminal blocks provided in each unit.
  - d. For starters Size 3 and larger, terminate control wiring and external field control wiring on terminal blocks provided in each unit.
2. Terminal blocks associated with non-removable units within the motor control center shall be provided in accordance with Section 26 09 16 – Electric Controls and Relays.
3. Provide a minimum of four (4) spare terminals in each terminal block assembly.

#### L. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 26 09 16 – Electric Controls and Relays:
  - a. Pilot devices (switches, indicating lights, etc.)
  - b. Relays and timers

#### M. Nameplates

1. Provide engraved plastic nameplates to identify the motor control center, each unit compartment, door mounted devices, and internal components.
2. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems. Equipment names and numbers as indicated on the single line diagrams shall be used as the basis to engrave the nameplates.
3. Provide a master nameplate giving motor control center designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
4. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

#### N. Future Space Requirements

1. Provide spaces for future combination starter and other units in the motor control centers. Furnish spaces with hardware to accommodate future plug-in control unit without modification of vertical sections. Provide the number of spaces required for future units as indicated on the Drawings, minimum.
2. Provide additional vertical sections to ensure total number of spaces as indicated on the Drawings. The number of vertical sections is contingent upon specific manufacturer's final proposed and Engineer-accepted configuration of motor control center units.

#### O. Motor Control Center Additions

1. The Contractor shall furnish and install complete motor control center sections or individual motor control center units to be added to existing motor control centers in accordance with these Specifications and as indicated on the Drawings.
2. These additions shall be of the same manufacturer, type, rating, and color as the existing motor control centers. Furnish and install all hardware necessary to

connect the buses of the new and existing motor control centers, including ground buses. Enclosures shall match existing.

P. Motor Control Center Modifications

1. The Contractor shall modify existing motor control centers and specific motor control center units as specified herein and indicated on the Drawings. These modifications include, but are not limited to, additions of door mounted pilot devices, modifications to existing motor control circuits and other work.

Q. Metering

1. Each motor control center assembly shall be furnished and installed with an Eaton Power Xpert 4000 power quality meter and graphic display module or Allen-Bradley equivalent PowerMonitor 3000 with display module as indicated on the Drawings. A communication expansion card to support Ethernet communication to the plant control system and a 1GB memory card shall be provided with each meter.

R. Surge Protective Devices

1. Surge protective devices (SPD) shall be provided either integral to the MCC enclosure or as a separate unit external to the MCC enclosure, as indicated on the Drawings. See Section 26 43 13 – Surge Protective Devices for SPD requirements.

## 2.03 DEVICENET COMMUNICATIONS

A. The motor control center shall have DeviceNet wiring incorporated into its design.

1. The motor control center shall have DeviceNet cabling incorporated throughout the vertical section.
2. Each motor controller shall be supplied with a means to communicate via DeviceNet.
3. Where specified or indicated on the Plans, the status of main and feeder circuit breakers shall be communicated via DeviceNet.

B. DeviceNet Cabling

1. All units shall be interwired and tested as a NEMA Class II motor control center
2. Cable Ratings



- a. The DeviceNet cable shall be in compliance with Article 300.3(C)(1) of the National Electrical Code, 2005
  - b. The insulating rating shall be equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway.
  - c. No special separation, barriers or internal conduit shall be required for the DeviceNet conductors.
  - d. The trunk line cable shall be flat cable rated eight amperes, 600V, Class 1.
  - e. The cable used to connect a unit to a DeviceNet port in the vertical wireway shall be round cable rated eight amperes, 600V, Class 1.
3. Layout
- a. A DeviceNet trunkline shall be routed through the motor control center lineup. To prevent accidental mechanical damage during motor control center installation, and trunkline shall be located behind barriers that isolate the trunkline from the unit space and wireways.
  - b. A minimum of six (6) DeviceNet ports shall be provided in the rear of each vertical wireway to simplify installation, relocation, and addition of plug in units.
  - c. The DeviceNet component within each unit shall be connected to its respective DeviceNet port.
4. Power Supplies
- a. The motor control center manufacturer shall check the user's design to ensure that adequate power supplies have been specified to conform with DeviceNet requirements.
  - b. The power supply shall provide 24VDC for the DeviceNet system, be rated no less than eight (8) amperes, and be redundant with automatic switching.
  - c. The power supply for the motor control center DeviceNet system shall be supplied as a separate plug-in unit.

## C. DeviceNet Interfaces

### 1. Motor Starter Units

- a. Motor starter units shall be furnished and installed with an E3+ electronic overload relay that incorporates the following features.

- 1) On-board DeviceNet communications
  - 2) LEDs for status indication
  - 3) Test / Reset Button
  - 4) Adjustable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation.
  - 5) Four inputs and two outputs.
  - 6) Protective functions shall provide a programmable trip level, warning level, time delay and inhibit window.
  - 7) Protective function shall include thermal overload, underload, jam, current imbalance, stall, phase loss, zero sequence ground fault and PTC thermistor input.
  - 8) Current monitoring functions shall include phase current, average current, full load current, current imbalance percent, percent thermal capacity utilized and ground fault current. For Size 4 and larger starters, ground fault current transformers shall be furnished and installed.
  - 9) Diagnostic information shall include device status, warning status, time to reset, trip status, time to overload trip and history of last five trips.
2. Reduced Voltage Solid State Starters and Variable Frequency Drives
- a. DeviceNet communication interface shall be supplied to allow for communications between VFDs/RVSSs and the DeviceNet system. Each RVSS starter and VFD integrated into a motor control center shall be furnished with a 20-COMM-D Module to enable DeviceNet Communication between the motor controllers and the PLC based plant control system.
3. Miscellaneous Units
- a. Provide a DeviceNet interface for miscellaneous units as indicated on the Drawings and as required to result in a complete and operable system.
  - b. The DeviceNet interface shall have four inputs and two outputs.
  - c. Refer to the Drawings and Specifications for points to be monitored.

#### D. Programming and Testing

1. The motor control center manufacturer shall load the DeviceNet MAC ID number (node address) into each unit.
  2. The DeviceNet MAC ID number shall be as indicated or as provided by the Contractor.
  3. The DeviceNet network shall be designed and programmed for use at 250kB or 500kB.
  4. The motor control center manufacturer shall factory test the motor control center to ensure that each unit communicates properly prior to shipment.
  5. Each DeviceNet device shall have a label showing the unit location, node address and baud rate.
  6. The motor control center manufacturer shall provide a disk containing applicable Electronic Data Sheet (EDS) files for the DeviceNet devices.
- E. The motor control center manufacturer shall coordinate with the Instrumentation and Control Subcontractor (System Integrator, reference Specification Section 40 61 13 – Process Control System General Provisions) and the Contractor regarding any required DeviceNet materials external to the motor control center. A complete DeviceNet network consists of DeviceNet cabling, components with DeviceNet nodes, DeviceNet power supply and DeviceNet scanner (or linking device).
- F. DeviceNet-to-Ethernet Gateway
1. Each “half” of the main-tie-main configured motor control center shall be furnished and installed with a DeviceNet-to-Ethernet Gateway. That is, each bus, A and B, shall be furnished with a DN/EN Gateway resulting in two gateways and two networks per motor control center.
  2. The gateway shall be a 1788-EN2DN Linking Device. The DeviceNet “Scanner” card shall be embedded into this linking device. The linking device shall also include the Auto Device Replacement (ADR) functionality using a dedicated memory allocation within the DeviceNet scanner.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. The motor control centers shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

- B. Install motor control centers to allow complete unit door swing required for unit removal. This is specifically required where a vertical section of motor control center is set next to a wall to the left of the motor control center section.
- C. Where motor control center structures are located away from walls to allow bottom conduit entry, the Contractor shall furnish and install sheet metal coverings for openings along the sides and top of the motor control center line-up. The purpose of the coverings is to minimize dust, dirt, and undesirable materials from collecting behind the equipment. The sheet metal coverings shall be of the same material, gauge, and finish as the motor control center.
- D. Motor control centers shall be furnished with anchor bolts as required for aligning and mounting. Floor channels with end covers shall be of type recommended by the manufacturer and shall be furnished for installation in a concrete pad.
- E. All field wiring that is terminated directly to a unit within the motor control center shall be neatly routed in a manner that does not hinder the ability to service, adjust, or replace components within that unit. Field wiring shall be properly anchored to the motor control center and individual unit structures.
- F. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  - 1. Witnessed Shop Tests
    - a. None required.
  - 2. Certified Shop Tests and Reports
    - a. Submit description of proposed testing methods, procedures, and apparatus. Submit notarized and certified copies of all test reports.
    - b. As a minimum, the entire motor control center shall go through a quality inspection before shipment. This inspection shall include, but is not limited to, the following:
      - 1) Physical inspection of the structure and the electrical conductors including bussing, general wiring, and units.

- 2) General electrical tests including power circuit phasing, control circuit wiring, instrument transformers, meters, ground fault system, and device electrical operation.
  - 3) AC dielectric tests of the power circuits and control circuits.
  - 4) Markings/labels, including instructional type, Underwriters Laboratory (UL), and inspector's stamps.
3. The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the motor control center.

**B. Field Tests**

1. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

**3.03 FIELD ADJUSTMENTS**

- A. All adjustable settings of circuit breakers shall be set in the field by a qualified representative of the manufacturer, or an outside testing company retained by the Contractor, in accordance with the settings designated in the coordination study. See Section 26 05 00 – Basic Electrical Requirements.
- B. The settings of the motor circuit protectors and overload relays shall be set based on the coordination study and the motor nameplate data of the motors installed.

**3.04 SERVICES OF MANUFACTURER'S REPRESENTATIVE**

- A. The Contractor shall provide the services of a qualified, factory-trained manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform startup and functional testing of the equipment as specified herein.
- C. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for One (1) sessions of two (2) hours. Training shall be at times coordinated with the Owner.

- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
1. One (1) trip of one (1) working day during the installation and startup of the equipment.
  2. One (1) trip of one (1) working day two (2) months before the warranty expiration to identify any issues to be corrected under warranty.
  3. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

**END OF SECTION**

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install all switches, and receptacles as shown on the Drawings.
- B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 26 05 33.16 – Boxes for Electrical Systems for outlet box requirements.
- C. Reference Section 26 05 00 – Basic Electrical Requirements and Section 26 05 19 – Low-Voltage Conductors and Cables.

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Wiring devices shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 2. Underwriters Laboratories (UL):
    - a. UL 20 – General Use Snap Switches.
    - b. UL 498 – Standard for Attachment Plugs and Receptacles.
    - c. UL 943 – Ground Fault Circuit Interrupters.
    - d. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

**1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include, but not be limited to:
  - 1. Product data sheets.

**1.05 SPARE PARTS**

- A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

**1.06 IDENTIFICATION**

- A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

**PART 2 – PRODUCTS****2.01 MANUFACTURERS**

- A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The Contractor shall use the products of a single manufacturer for each type of wiring device.
- C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:
  - 1. Where the selected plate manufacturer does not manufacture a suitable finish plate.
  - 2. For heavy-duty receptacles rated at more than 30A.



3. Where non-standard plates are required, specified, or shown.
- D. The Contractor shall furnish and install all wiring devices and device plates.
- E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, or Engineer approved equal.
- F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

## 2.02 WIRING DEVICES

- A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double -pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120-277VAC and shall be UL 20 Listed.
- B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VAC and shall be UL 498 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.
- C. Special purpose receptacles (e.g., welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.
- D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VAC and shall be UL 943 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.
- E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A.
- F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.
- G. Wiring devices shall be approved for use with stranded conductors if stranded conductors are to be used with the device. Reference Section 26 05 19 – Low-Voltage Conductors and Cable for conductor requirements

## 2.03 DEVICE PLATES

- A. Device plates for indoor flush-mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled on the rear so as to lie flat against the wall. Devices plates shall be provided with a gasket.

- B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK-1VS-A, Crouse-Hinds #DS185, or Engineer approved equal for wall switches. Device plates for receptacles shall be "in-use" style, and shall be fully closable when a plug/cord is inserted. "In-use" weatherproof covers shall be rugged, minimum 3 ¼" depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or Engineer approved equal.
- C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32 or Engineer approved equal for switches, and Crouse-Hinds DS23 or Engineer approved equal for receptacles.

## **2.04 PLUGS**

- A. The Contractor shall furnish suitable plugs with equipment furnished under the respective Specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

## **2.05 PROCESS INSTRUMENTS**

- A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument, etc.) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or Engineer approved equal. For hazardous locations, the device shall be UL 1203 Listed.

# **PART 3 – EXECUTION**

## **3.01 INSTALLATION**

- A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.
- B. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and outlet boxes.
- C. Wiring device box (outlet box) mounting heights shall be as specified in Section 26 05 33.16 – Boxes for Electrical Systems.
- D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.

- E. Receptacles installed in toilet, locker, and bathrooms, and within 6 feet of a sink, shall be of ground fault circuit interrupter (GFCI) type. GFCI receptacles shall also be furnished and installed in additional locations where indicated on the Drawings, and as required by the NEC.
- F. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14-point font.

### **3.02 CIRCUITING**

- A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

**END OF SECTION**

**SECTION 26 28 16.16**  
**ENCLOSED SWITCHES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, test, and place in satisfactory operation separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.
- B. Disconnect switches for process instruments are not included in the scope of this Section and shall be as specified in Section 26 27 26 – Wiring Devices.
- C. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 53 – Identification for Electrical Systems

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Disconnect switches shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. National Electrical Manufacturers Association (NEMA):
    - a. NEMA 250 – Enclosures for Electrical Equipment.
    - b. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
  - 2. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 3. Underwriters Laboratories (UL):
    - a. UL 98 – Enclosed and Dead-Front Switches.

### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Spare Parts List
  - 3. Each submittal shall be identified by the applicable Specification Section.

### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.
  - 3. Assembled weight of each unit.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

### 1.05 SPARE PARTS

- A. The equipment shall be furnished with all spare parts as recommended by the equipment manufacturer.
- B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.
- C. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

**1.06 IDENTIFICATION**

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the equipment name with which it is associated (e.g., DB-EF-1). Equipment identification shall be in accordance with Section 26 05 53 – Identification for Electrical Systems.

**PART 2 – PRODUCTS**

**2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Switches shall be manufactured by the Square D Company, Eaton, the GE by ABB, Rockwell Automation (Allen-Bradley), or Siemens Energy and Automation, Inc.

**2.02 DISCONNECT SWITCHES**

- A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.
- B. Disconnect switches for non-hazardous areas shall be UL 98 Listed.
- C. Switches shall meet NEMA Standard KS 1 type HD requirements, be, single-throw, be externally operated, and be fused or non-fused as indicated on the Drawings. Switches shall have the number of the poles, voltage, and ampere ratings as shown on the Drawings.
- D. Enclosure Types and Materials
  - 1. In non-hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel

Area Designation	Enclosure Type and Material
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

- E. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.
- F. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.
- G. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides "finger-safe" protection when the door of the enclosed switch is open.
- H. Disconnect switches shall be furnished with a manufacturer-supplied ground lug kit for termination of equipment grounding conductors. Where a grounded (neutral) conductor is shown on the Drawings in the conduits connected to the disconnect switch, a manufacturer-supplied neutral bar shall be furnished for termination of the grounded conductors. Third party ground lug and neutral lug kits not supplied by the disconnect switch manufacturer are not acceptable.
- I. Fused disconnect switches shall be furnished for motor operated valve and gate actuators where shown on the Drawings. The Contractor shall coordinate the supply of these fused switches with the specific requirements of the actuator. Fuses with fast fault clearing times may be required for modulating valve actuators.
- J. Disconnect switches for all motors connected to variable frequency drives (VFDs) shall be furnished with a factory installed electrical interlock kit that includes one (1) early-break auxiliary contact rated for 5A (minimum) at 120 VAC to be used to open the control circuit before the main switch blades break.
- K. Disconnect switches for use on circuits utilizing shielded VFD cable(s), shielded submersible pump cable(s), or similar special cable constructions, shall be furnished with the configuration, accessories, and/or appurtenances necessary for use with such cables as described in Part 3 herein.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Disconnect switches shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the operating handle mechanism (and not to exceed 6ft 7in to the center of the operating handle grip when in its highest position), at the equipment height where appropriate and permitted by the NEC, or where shown otherwise.
- B. Disconnect switches shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- C. Where disconnect switches are shown on the Drawings to be installed on circuits utilizing shielded VFD cable(s), shielded submersible pump cable(s), or similar special cable constructions, the Contractor shall coordinate the configuration and installation of the disconnect switches with the switch manufacturer and respective cable and/or pump/equipment manufacturer(s). These types of cables require special methods to be utilized for termination, grounding, etc., and may also require the addition of isolated (from other ground conductors, enclosure/raceway grounding, etc.) ground/shield termination provisions in the disconnect switch for pass-through of the cable internal shield/ground conductor(s). Properly coordinating and executing the configuration and installation of disconnect switches with these cable types shall be the sole responsibility of the Contractor.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  - 1. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

**END OF SECTION**



**SECTION 26 29 23**  
**LOW VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFDs) as specified herein and indicated on the Drawings.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 53 – Identification for Electrical Systems
  - 3. Section 26 43 13 – Surge Protective Devices
  - 4. Section 26 09 16 – Electric Controls and Relays
- C. The Contractor is responsible for coordinating with the driven equipment manufacturer and the VFD manufacturer to ensure that the VFD is sized properly to meet all of the requirements herein. This includes, but is not limited to, accounting for motor RPM and variable or constant torque applications. The Contractor is responsible for including any costs related to equipment upsizing, conduit and wire upsizing, etc. that results from selecting equipment with a higher full load amp rating than was specified or used as the basis for design.
- D. The variable frequency drives shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

**1.02 CODES AND STANDARDS**

- A. VFDs shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. NEMA 250 – Enclosure for Electrical Equipment
  - 2. IEEE 519 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
  - 3. NEMA ICS 7 – Adjustable-Speed Drives

4. NEMA ICS 61800-2 – Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems
5. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
6. UL 508A – Standard for Industrial Control Panels
7. UL 508C – Standard for Power Conversion Equipment

### **1.03 DEFINITIONS**

- A. The following definitions are provided for clarity with regard to the language used in this Specification:
  1. Variable Frequency Drive (VFD) – The complete custom-engineered VFD as packaged within an overall enclosure, including the VFD unit and all other components within that enclosure as specified herein.
  2. VFD Unit – The solid-state power electronic device or devices within the VFD.

### **1.04 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in General Conditions and Section 01 30 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  1. Shop Drawings
  2. Operation and Maintenance Manuals
  3. Spare Parts List
  4. Reports of Certified Shop and Field Tests
  5. Manufacturer's Field Start-up Report
  6. Manufacturer's Representative's Installation Certification
  7. Pre- Equipment-Selection Harmonic Study Report

### **1.05 PRE-EQUIPMENT-SELECTION HARMONIC STUDY**

- A. A comprehensive pre-equipment-selection harmonic study shall be prepared by the Contractor. The results of this pre-equipment selection study shall be submitted to the Engineer as part of the submittals specified herein. Should this study indicate the need for additional tuned filters, line reactors, isolation transformers, or other harmonic

distortion suppression equipment, these shall be supplied and included in the Bid. Indicate the location of the harmonic suppression equipment in the submittal data. Location is subject to acceptance by the Engineer.

- B. The harmonic distortion values resulting from operation of all or any variable frequency drive-driven motor-load combinations operating at full load shall be as defined in latest edition of IEEE Standard 519.
- C. System single line diagrams and field access to the plant site will be provided to the Contractor for the purpose of providing this study. Contractor shall obtain from others other information that may be necessary to perform this study. Input data and other pertinent information used in harmonic study shall be coordinated by the Contractor with the following:
  - 1. Input data/information/results of the short circuit fault analysis specified herein.
  - 2. Electrical system configuration and electrical equipment shop drawing submittal data including, but not being limited to new non-linear loads, new linear loads, and new capacitors.

#### **1.06 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings **for each VFD** shall include but not be limited to:
  - 1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Complete bill of material and catalog data sheets for all equipment and devices comprising the VFD.
3. Heat loss data for each VFD.
4. Manufacturer's warranty information.
5. Product data sheets for **all** system components, including but not limited to:
  - a. VFD units
  - b. Motor overloads
  - c. Harmonic correction devices and/or equipment, e.g. line reactors, passive filters, and 18-pulse phase-shifting transformers
  - d. Output reactors and/or output filters
  - e. Pilot lights and pilot devices
  - f. Control and timing relays
  - g. Enclosure fans
  - h. Contactors
  - i. Power supplies
  - j. Control power transformers
  - k. Current transformers
  - l. Potential transformers
  - m. Circuit breakers and/or motor circuit protectors
  - n. Fuses
  - o. Terminal blocks (power, control, and shorting)
  - p. Surge protective devices
6. Layout drawings of the VFD that include:
  - a. All cabinet or enclosure dimensions, access details, and weights.
  - b. Required clearances around the enclosure, e.g. ventilation.

- c. Conduit entry areas and/or stub-up locations.
- d. Nameplate sizes, colors, and locations.
- e. Physical arrangement of door mounted devices located on the variable frequency drive enclosure.
- f. Physical arrangement of **all** interior components, including DIN-rail-mounted devices.

General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

- 7. Custom schematic and interconnection wiring diagrams of all electrical work, including but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, terminal blocks and identification numbers, wire numbers, and other equipment comprising the complete system.
  - a. These drawings shall be circuit specific for each motor-load combination (e.g. MAU-SF-1, MAU-EF-1, etc.). Specific equipment names consistent with the Drawings shall appear on each respective diagram.
  - b. Indicate all devices, regardless of their physical location, on the schematic diagrams.
  - c. Electrical ratings of all equipment and devices shall be clearly indicated on the schematic diagrams.

Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable.

- 8. Confirmation of spare parts requirements as specified herein.
  - 9. Table listing all motor loads connected to the VFD. Table shall include the full load amps of the APPROVED motors. Final approval of VFD shop drawings cannot be given until all motor loads for each VFD have been reviewed, approved, and shown in this table.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

### 1.07 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01 30 00 – Submittal Procedures .
- B. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD. These final drawings shall be included in the O&M manuals and an additional copy that is plastic laminated shall be securely placed inside each VFD.
- C. The O&M manual shall include the "as-commissioned" parameters of each VFD in both print and digital formats.
- D. If the VFDs require computer software or configuration, the O&M manual shall include copies of all programming guides/manuals.

### 1.08 SPARE PARTS

- A. The VFDs and accessories shall be furnished with all spare parts as recommended by the equipment manufacturer. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts:
  - 1. Two (2) sets of fuses for each size and type of fuse provided.
  - 2. One (1) HMI per type of HMI provided.
  - 3. One (1) set of enclosure air filters for each VFD.
  - 4. For each VFD unit **without** field-replaceable internals, furnish one (1) spare VFD unit per size provided.
  - 5. For each VFD unit **with** field-replaceable internals, furnish one (1) fully functional main control circuit board per VFD unit size provided.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.
- D. Spare parts lists included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

## 1.09 WARRANTY

- A. Contractor shall warrant that the material and workmanship of all components and the operation of the VFDs and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.
- B. Warranty shall include, but not be limited to the following:
  - 1. Replace components found to be faulty and make changes in equipment arrangement or make adjustments necessary to meet the equipment or functional requirements or this Specification.
  - 2. System rewiring and component substitution/rebuild.
  - 3. All accessories and appurtenances provided by the VFD manufacturer.
- C. Warranty shall be in effect for a period of 24 months following final acceptance of each VFD.

## PART 2 – PRODUCTS

### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The Contractor shall obtain the VFDs from one manufacturer who shall also manufacture and assemble the enclosure and major equipment components including, but not limited to the VFD unit and bypass starters. The manufacturer shall have five years minimum of experience in the manufacture of similar units and shall have a general distribution to the electrical trade. **Subcontracting of wiring and/or third-party assembly is not acceptable.**
- C. The VFDs shall be manufactured by Eaton, the Square D Company, Rockwell Automation (Allen-Bradley), ABB, or Toshiba.
- D. The Contractor shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements

from the appropriate sources and integrating these into a VFD that fulfills the requirements of this Specification.

**2.02 VFD SYSTEMS**

A. Operating Conditions

1. The following operating conditions are applicable for all equipment of this Specification.
  - a. Humidity: 0-95%.
  - b. Ambient Temperature: 0 degrees Celsius to plus 40 degrees Celsius.
  - c. Altitude: up to 5,000 feet

B. Basic Design and Performance

1. Each VFD shall be a complete alternating current electric drive system including all hardware and software necessary to accomplish variable speed operation of a motor and load combination. VFDs shall be provided in accordance with the requirements indicated on the Drawings and as described in these Specifications.
2. Each VFD shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete VFD system shall have a minimum short circuit current rating of 65,000 amperes symmetrical at rated voltage.
3. **The Contractor** is fully responsible for the review of the full Contract Documents to determine specified motor speed, horsepower and full load ampere requirements for each motor-driven load. In addition, the Contractor shall size and select the VFD and components as follows:
  - a. Each VFD shall provide, continuously, motor load current equal to 100% of the direct on-line motor nameplate full load current.
  - b. Each VFD shall be selected for Variable Torque (Normal Duty) or Constant Torque (Heavy Duty) based on its respective load type served as shown in the Load Type tables below.

Variable Torque (Normal Duty) Load Types	Constant Torque (Heavy Duty) Load Types
HVAC Fan Loads	Not Included Under this Contract



- c. The Load Type tables above are intended to exhaustively cover all possible equipment controlled by VFDs to be provided under Division 26 for this Contract. If a piece of equipment is found that is not explicitly listed in these tables, this discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution **prior to submitting the Bid for this Contract.**
4. Each VFD shall be suitable to operate, at times, on a limited power source engine-generator set. The VFD shall be provided with equipment and devices to prevent waveform distortion as specified herein.
5. Each VFD shall be provided with control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks. Each VFD shall be designed such that specific control and protection functions can be attained through simple programming by either factory engineers or Owner's trained operating personnel.
6. Unless otherwise accepted in writing by the Engineer, VFDs shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals that exceed the ratings of the inverter duty rated motor winding insulation.
  - a. **The Contractor** is responsible for providing the VFD manufacturer with estimated and field-verified cable lengths between each VFD and its respective motor. The VFD manufacturer shall select and size the output reactors or filters based on the cable lengths provided by the Contractor. Any change in output filter or reactor selection and/or size from the Bid shall be immediately brought to the attention of the Engineer in writing for resolution.
  - b. The output filters or reactors shall be as manufactured by TCI, MTE Corporation, Mirus International, or engineer approved equal.
7. Motor control circuits shall be wired in accordance with the requirements specified herein and/or indicated on the Drawings.

### C. Components

1. Each VFD shall contain the number of VFD units as shown on the Drawings and required for the applications.
2. Each VFD shall contain and/or be furnished with the harmonic correction equipment as required for the applications. Harmonic correction equipment shall be as specified elsewhere in this Specification.
3. Each VFD shall contain the number of auxiliary contacts, control power transformer(s), pilot devices and indicating lights, control relays, elapsed time meters, and other devices as specified herein, shown on the Drawings and required for the applications. The following components shall meet the requirements of Section 26 09 16 – Electrical Controls and Relays:
  - a. Pilot devices (switches, indicating lights, etc.)
  - b. Relays and timers
  - c. Terminal blocks
4. Power terminal blocks for VFD output to the motor shall be fixed-mounted to a backplane or the enclosure. Mounting the terminal blocks on DIN rails is not acceptable.
5. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.
6. Each VFD shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.
7. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100% redundant. New and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be provided in lieu of 100% redundant auxiliaries if accepted in writing by the Engineer.
8. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished.
9. Circuit Breakers

- a. Where indicated on the Drawings, VFDs shall be protected by a UL 489 Listed circuit breaker.
- b. Unless otherwise indicated, circuit breakers shall be manually operable and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous short-circuit protection.
- c. Circuit breakers shall be molded case type, rated 480 VAC, 3 pole and have 100 ampere or larger frames. The interrupting rating shall match that of the VFD short circuit rating at 480V.
- d. Overload protection shall be provided on all poles with trip settings as indicated on the Drawings. Breakers of 225-ampere frames and larger shall have interchangeable solid-state electronic trip units.
- e. Where indicated on the Drawings, shunt trip devices shall be provided to trip a circuit from a remote location by means of a trip coil energized from a separate circuit. A 120V shunt trip shall be capable of operating at 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

#### D. Controls

1. Each VFD shall be provided with automatic and manual controls as shown on the Drawings and as required to comply with all Specifications. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings.
2. The Elementary Control Schematics shown on the Drawings are **representative of design intent only**. The manufacturer shall be responsible for providing all additional components, controls, and internal wiring necessary to meet the design intent.
3. VFD circuitry shall be designed such that the enclosure cooling fans only run when the VFD unit is producing output power. Designs that allow the enclosure cooling fans to run continuously when the VFD unit is energized but not producing output power are not acceptable. Fans that are used exclusively to provide cooling for the VFD unit (and not the overall enclosure) are permitted to run continuously if required by the VFD manufacturer's design standards/practices.

#### E. Enclosures

1. Equipment within the VFD enclosure shall be arranged so that it does not interfere with the entry of conduits and cables into the enclosure.

2. All pilot devices (selector switches, pushbuttons, indicating lights, etc.) and the human machine interface (HMI, specified elsewhere herein) shall be door mounted on the exterior of each VFD enclosure. Manipulation of the pilot devices or HMI, viewing of the information on the HMI, or viewing that status of pilot devices shall not require the VFD enclosure door to be opened.
3. Unless otherwise indicated on the Drawings, VFDs in non-hazardous locations, shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

4. VFDs shall not be installed in hazardous locations.
5. NEMA 1 and NEMA 12 VFD enclosures shall be force ventilated with front accessibility and the following:
  - a. Enclosures shall be provided with washable enclosure air intake filters that can be replaced while the enclosure door remains closed.
  - b. Enclosures shall be designed for bottom or top entry of conduits and cables as required.
  - c. Enclosures shall be finished in ANSI-61 gray enamel or in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.
6. NEMA 4X VFD enclosures shall be air conditioned, dead-front, with front accessibility and the following:
  - a. The air conditioning system shall utilize a heat-exchange method that allows for cooling of the enclosure interior without circulating outside air through the enclosure.

- b. Enclosures shall be furnished with tubular type enclosure space heaters. Space heaters shall be rated at 500V or 250V and operated at 240V or 120V, respectively.
  - c. VFDs shall be furnished with an additional control power transformer sized to provide power exclusively for the air conditioning system and enclosure space heater.
  - d. VFDs shall be furnished with a tamper-resistant hinged cover with a clear polycarbonate viewing window over the door-mounted pilot devices.
  - e. VFDs shall be designed for bottom entry of cables/conduits only.
7. Each VFD shall be designed such that rear access to the enclosure is not required for operations, maintenance, or repair tasks.
8. The Contractor shall reference the Drawings for maximum dimensions of the VFDs. The Engineer shall be notified prior to the initial shop drawing submittal if exceptions to the dimensions indicated on the Drawings are to be requested.
9. Enclosure doors shall have full length piano type hinges and shall be braced to prevent sag when fully open.
10. Each VFD enclosure shall be supplied with an industrial, heavy-duty flange-mount handle mechanism for the operation of the VFDs disconnecting means as follows:
  - a. The mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position.
  - b. The operator handle shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator.
  - c. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8-inch diameter shackle padlock.
  - d. The operator handle shall be mechanically interlocked such that the disconnecting means cannot be closed with the enclosure door open, nor can the enclosure door be opened when the disconnecting means is closed. A defeater mechanism shall be provided so that qualified personnel can bypass these interlocks for maintenance and testing purposes. The defeater mechanism shall allow the enclosure door to be opened without interrupting the operation of the VFD.

#### F. Nameplates and Legend Plates

1. Provide engraved plastic nameplates and legend plates to identify each VFD and associated door mounted devices and internal components. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.
2. Equipment names and/or numbers and device identification text shown on the Drawings shall be used as the basis to engrave the nameplates and legend plates. Where the equipment identification text would exceed the capacity of the VFD manufacturer's standard nameplate/legend plate size, the manufacturer shall provide larger nameplates and/or additional nameplates as necessary. Abbreviating equipment names/numbers and device identification text is not acceptable.
3. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked with identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

### **2.03 VFD UNITS**

- A. The VFD unit shall be the Eaton PowerXL DG1 series, Square D Altivar 600 series, Rockwell Automation (Allen-Bradley) PowerFlex 750 series, ABB ACQ 580 series, or Toshiba AS3/W7 series.
- B. Basic Design and Performance
  1. Each VFD unit shall be of adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 VAC NEMA Design A or B induction motors. Units for other than NEMA Design A or B induction motors (e.g., NEMA Design C) shall be coordinated with the requirements of that respective load.
  2. Each VFD unit shall consist of a semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the motor at the desired speed.
  3. Each VFD unit shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

4. The overall efficiency of each VFD unit shall be a minimum of 95% when operating the specified motor-load combination at rated voltage, frequency, and current.
5. Each VFD unit shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed. The VFD unit shall be provided with adjustable maximum and minimum frequency limits.
6. Each VFD unit shall maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5% of rated frequency of 60 Hertz for a 24-hour period and a repeatability of 0.1% of rated frequency of 60 Hertz.
7. Each VFD unit shall be capable of operating the specified load continuously at any speed within the operating speed range of 10% to 100% of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.
8. Each VFD unit shall be capable of controlled linear acceleration and deceleration. Each VFD unit shall be capable of ramping the speed of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Each VFD unit shall have two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.
9. Voltage or current unbalance between phases of the VFD unit output voltage shall not exceed 3% of the instantaneous values. The VFD unit shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3%. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.
10. Each VFD unit shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10% for a duration of 15 cycles. VFD unit output voltage regulation shall be plus or minus 2%.

#### C. Features and Characteristics

1. Each VFD unit shall be furnished with a Human Machine Interface (HMI) to provide controls and indication to accomplish maintenance and operational functions as specified herein and shown on the Drawings. The HMI shall be password protected after startup to prevent unauthorized personnel from making changes. The HMI shall at minimum provide indication of the following:

- a. Input Voltage
  - b. Output Voltage
  - c. Output Current
  - d. Output Frequency
  - e. Output Speed from 0-100%
  - f. Alarm Read-out
2. Each VFD unit shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback/speed indication to external equipment.
  3. Each VFD unit shall accept a 4-20 mADC speed input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed equal to or less than 0.1% of rated speed.
    - a. Where shown on the Drawings, VFD units shall also accept a 0-10VDC input from a speed potentiometer for manual speed control. Each VFD unit shall be capable of automatically switching between the input speed command signals as shown on the Drawings.
  4. Input Voltage Loss Handling
    - a. The VFD unit shall shut down upon a loss of one or more input phases, a 3-phase complete input power loss, or a sustained input undervoltage event. A sustained input undervoltage event is defined as voltage that is less 75% of nominal, for more than 0.5 seconds.
    - b. Upon restoration of 3-phase power that is at an acceptable voltage level, the VFD unit shall automatically reset (after an adjustable time delay, 0-2 minutes) and be capable of being restarted and ramping up to speed when remotely commanded through the control system or locally commanded at any local controls. Personnel shall not be required to reset the VFD unit manually after a shutdown caused by any input voltage loss event.
    - c. Automatic reset of the VFD unit shall be achieved through programming/parameter setpoints, time delay relays, or a combination of both.
  5. Each VFD unit shall have a multiple attempt restart feature.



6. Each VFD unit shall have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The VFD unit shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.
7. Each VFD unit shall be furnished with programmable electronic overload and torque limits.
8. Each VFD unit shall have an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall lock-out the VFD unit and indicate the fault only upon the following conditions:
  - a. Output voltage unbalance (trip threshold field set).
  - b. Loss of phase on output.
  - c. Motor overload.
  - d. Motor stator winding fault (phase-to-ground, phase-to-phase).
  - e. Unacceptable voltage variation.
  - f. High variable frequency drive equipment temperature.
  - g. VFD failure as determined by the manufacturer.
  - h. Component failure.
  - i. Overcurrent.
9. Provide each VFD unit with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the VFD unit, this feature shall be capable of being disabled.
10. Each VFD unit shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure.
  - a. Diagnostics shall operate a visual alarm indicator on the HMI.
  - b. Diagnostics shall provide an easily readable output that can be used to isolate a failure.

- c. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.
    - d. Provide normally open and/or normally closed dry contacts as indicated on the Drawings for VFD failure conditions .
11. Each VFD unit shall communicate the following parameters to the control system via Ethernet/IP protocol. Provide any necessary hardware gateways to provide this communication capability. The following parameters, at a minimum, shall be communicated:
  - a. Motor current (all phases)
  - b. Motor voltage (all phases)
  - c. Motor KW
12. Where indicated on the Drawings, provide input cards that allow connection of speed encoders to the VFD unit.
13. Each VFD unit shall be provided with input/output (I/O) cards including expansion cards as necessary to facilitate connection of all I/O specified herein and shown on the Drawings.

#### **2.04 HARMONIC CORRECTION**

- A. Harmonic correction devices for each VFD shall be as specified herein and located as shown on the Drawings.
- B. Input Line Reactors
  1. 6-pulse VFD units shall be provided with input line reactor and/or integral DC link reactor. Total reactor impedance shall be a minimum of 3% and shall not exceed 5%.
- C. Passive Filters
  1. Where indicated on the Drawings or where additional harmonic correction is required, 6-pulse VFD units shall be provided with a passive harmonic filter in addition to the integral DC link reactor specified above (if present.)
  2. Passive harmonic filters shall be sized to attenuate harmonics resulting from operation of the VFD-driven motor load to no more than 5% THID when operating at full load, and no more than 8% THID when operating at 30% of full load. The filter shall be equipped with power contactors configured to remove the capacitors

from the circuit when the VFD-driven loads are not in operation. The harmonic filters shall be as manufactured by TCI, MTE Corporation, Mirus International, or Engineer approved equal.

3. Passive filters shall be integrated into the VFD unless accepted in writing by the Engineer or shown as separately mounted from the VFD on the Drawings.

D. 18-Pulse and Active Front End (AFE) VFDs

1. Where indicated on the Drawings, VFDs shall consist of either:
  - a. an 18-pulse VFD unit with an 18-pulse phase-shifting transformer, or
  - b. a VFD unit with an IGBT-based active front end (AFE).
2. AFE VFDs may be provided in lieu of 18-pulse VFDs (or vice-versa) **if accepted in writing by the Engineer.**

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. Install VFDs to allow complete door swing required for component removal.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  1. Witnessed Shop Tests
    - a. None required.
  2. Certified Shop Tests and Reports
    - a. Submit description of proposed testing methods, procedures, and apparatus.
    - b. Factory test the complete VFD in accordance with IEEE and NEMA standards.
    - c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

3. Field Tests
  - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA acceptance testing specifications referenced in Section 26 05 00 – Basic Electrical Requirements.
  - b. The Contractor shall field measure actual harmonic distortion with tests performed by an independent testing agency acceptable to the Owner after satisfactory full-load operation. The Contractor shall provide the harmonic distortion reports with the O&M Manual.
  - c. Unless otherwise indicated on the Drawings, the harmonic distortion measurements shall be made at each load center where VFDs are present.
  - d. Harmonic distortion measurements shall be made after VFD installation. One set of measurements shall be made with the VFD loads inactive, and one set of measurements shall be made with the VFD loads running at design capacity.
- B. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.
- C. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.
- D. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

### **3.03 SERVICES OF A MANUFACTURER'S REPRESENTATIVE**

- A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for one (1) session of four (4) hours each. Training shall not take place until after the VFDs have been installed and tested. Training shall be conducted at times coordinated with the Owner.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
  - 1. One (1) trip of one (1) working day during installation of the motor controllers.
  - 2. One (1) trip of one (1) working day to perform startup and field acceptance testing of the motor controllers.
  - 3. One (1) trip of one (1) working day to perform training as specified herein.
  - 4. One (1) trip of one (1) working day two (2) months before the expiration of the warranty to identify any issues to be corrected under warranty.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

### **3.04 PAINTING**

- A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

**END OF SECTION**

**SECTION 26 43 13**  
**SURGE PROTECTIVE DEVICES**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, install, and place in satisfactory operation the surge protective devices (SPD) as specified herein and indicated on the Drawings.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 19 – Low-Voltage Conductors and Cables
  - 2. Section 26 05 53 – Identification for Electrical Systems.

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE):
    - a. C62.41.1 – IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
    - b. C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low -Voltage (1000 V and less) AC Power Circuits.
    - c. C62.45 – IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
    - d. C62.62 – IEEE Standard Test Specifications for Surge -Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and less) AC Power Circuits.
  - 2. National Fire Protection Association (NFPA):
    - a. NFPA 70 – National Electrical Code (NEC).
  - 3. Underwriters Laboratories (UL):

- a. UL 1283 – Electromagnetic Interference Filters.
- b. UL 1449 – Surge Protective Devices.

### **1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  1. Shop Drawings
  2. Operation and Maintenance Manuals
  3. Spare Parts List

### **1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for re-submittal.
- C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.
- D. Shop drawings for each SPD shall include but not be limited to:
  1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
  2. Product Data Sheets.
  3. Detailed drawings showing weights and dimensions.

4. Wiring diagrams showing field connections.
  5. Proof that all products provided under this Section are UL Listed and Labeled by Underwriters Laboratories to UL 1449, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc.) will be considered acceptable.
  6. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.
  7. Proof that all products provided under this Section are UL Listed and Labeled by Underwriters Laboratories to UL 1283, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc.) will be considered acceptable.
  8. Manufacturer's Warranty Information
- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

#### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.

#### **1.06 SPARE PARTS**

- A. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.
- B. The Contractor shall furnish one (1) spare field replacement module of each type and rating provided under this Contract.
- C. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.



### **1.07 IDENTIFICATION**

- A. Each SPD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each SPD. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

### **1.08 WARRANTY**

- A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.
- B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the warranty period, shall be replaced by the manufacturer at no additional cost to the Owner.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. The SPD units shall be UL 1449 Listed and shall bear the UL mark. Units that are “manufactured in accordance with” UL 1449 or tested by other testing agencies “in accordance with” UL 1449 are not acceptable and will be rejected.
- B. Type II SPD units shall be UL 1283 Listed and shall bear the UL mark. Units that are “manufactured in accordance with” UL 1283 or tested by other testing agencies “in accordance with” UL 1283 are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.

### **2.02 PRODUCTS**

- A. Type I surge protective devices (SPD) shall be furnished and installed when shown without upstream overcurrent protection on the Drawings. Type II SPDs shall be provided in all other locations. Type II SPDs shall not require the use of a specific upstream overcurrent device. SPDs shall be provided in the location and quantity as shown on the Drawings.
- B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.
- C. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

- D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.
- E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

System Configuration	Modes of Protection	Number of Modes
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

- F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.
- G. The Nominal Discharge Current (In) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1200V	800V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1800V	1800V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	800V	800V	1200V	800V

- I. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.
- J. SPDs which are indicated to be installed externally mounted from the equipment that they protect shall be provided within a separate enclosure. The enclosure shall match or exceed the NEMA rating of the enclosure for the equipment that it is serving (e.g., NEMA1, NEMA 12, NEMA 4X, etc.).
- K. Each SPD shall be provided with the following accessories:

1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.
  2. Surge counter and audible alarm with reset/silence switch.
  3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.
- L. SPDs which are indicated to be installed integral to (within) the equipment that they protect shall be manufactured by the same manufacturer as the equipment. SPDs which are indicated to be installed externally/separately mounted from the equipment that they serve shall be manufactured by Eaton, ASCO/Emerson Network Power, Current Technologies, GE by ABB, or Square D.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. The SPD units shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. SPDs which are indicated to be integral with the equipment that they protect shall be installed within the enclosure for that equipment.
- C. Externally mounted SPDs shall be installed as follows:
  1. The SPD units shall be mounted such that the conductor lengths are as short as possible, but no greater than 36 inches. Any installation resulting in a conductor length of greater than 36 inches shall be reviewed with the Engineer as a special type of cable may need to be installed. For equipment such as panelboards, the Contractor shall relocate the circuit breaker that is to be connected to the SPD as needed to achieve the shortest conductor length possible.
  2. The Contractor shall use a close nipple to enclose the conductors between the SPD and the equipment served. However, if due to field conditions a 90 degree conduit bend is required to connect the SPD to the equipment that it serves, the bend shall have a minimum radius of 36 inches to eliminate any potential for sharp bends in the conductors.
  3. Conductors between the equipment served and the SPD shall be 600V power wire and cable as specified in Section 26 05 19 – Low-Voltage Conductors and Cables. The individual conductors shall be gently twisted and sized as indicated on the Drawings.
- D. Prior to energizing, the following shall be performed for each SPD:

1. Verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.
2. Verify that any neutral-to-ground bonding jumpers are installed as required.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  1. Shop Tests
    - 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, ANSI, and UL standards.
    - b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.
  2. Field Tests
    - a. None required.

**END OF SECTION**

**SECTION 26 50 00  
LIGHTING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.
- B. Reference the following Specification Sections:
  - 1. Section 26 05 00 – Basic Electrical Requirements
  - 2. Section 26 05 26 – Grounding and Bonding for Electrical Systems

**1.02 CODES AND STANDARDS**

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable.
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
    - a. IEEE C62.41.3 – Guide for Surge Voltages in Low-Voltage AC Power Circuits
  - 2. Illuminating Engineering Society (IES)
  - 3. National Fire Protection Association (NFPA)
    - a. NFPA 70 – National Electric Code (NEC).
  - 4. Underwriters Laboratories (UL)
    - a. UL 924 – Emergency Lighting and Power Equipment
    - b. UL 916 – Standard for Energy Management Equipment
    - c. UL 1012 – Standard for Safety Power Units Other Than Class 2
    - d. UL 1598 – Luminaires

**1.03 SUBMITTALS**

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts Lists
- B. Each submittal shall be identified by the applicable Specification Section.

**1.04 SHOP DRAWINGS**

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.
  - 3. Photometric curves.
  - 4. LED data including efficiency (Efficacy lumens/watt) information.
  - 5. LED Driver information
  - 6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
  - 7. Manufacturer's warranty information.
  - 8. System (entire fixture assembly) efficiency data.

- D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.
- E. Manufacturer's model/series and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a model/series describing the various types of fixtures shall be used as a guide only and does not exclude all the required accessories or hardware that may be required for a complete installation.

#### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.

#### **1.06 SPARE PARTS**

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following additional spare parts shall be furnished:
  - 1. A minimum of one (1) LED driver for every ten (10) drivers (of the same type) installed.
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

#### **1.07 LIGHTING CONTROLS**

- A. The lighting systems shall be controlled as specified herein and indicated on the Drawings.

#### **1.08 WARRANTY**

- A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.
- B. Warranty shall be provided for the entire fixture and shall include all parts and accessories.. Submittals received without written warranties as specified shall be rejected in their entirety.

**PART 2 – PRODUCTS****2.01 MANUFACTURERS**

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The fixture schedule indicates the basis-of-design manufacturer(s) for each fixture type. The Contractor shall submit photometric calculations for each space and/or area where the Contractor wishes to use an equivalent fixture in accordance with Section 26 05 00 – Basic Electrical Requirements. Fixtures will be approved or denied as equivalent on a per-fixture and/or per-space/area basis.

**2.02 FIXTURES**

- A. All lighting fixtures shall be furnished complete with all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all accessories, characteristics, and functionality as specified.
- B. Fixture leads shall be as required by NEC. Fixtures shall be grounded by the equipment grounding conductor in the conduit.
- C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.
- D. Emergency and exit fixtures shall be UL 924 Listed and have a minimum 90 minutes battery back-up.
- E. Fixtures for use in hazardous locations shall be UL 844 Listed.
- F. Fixtures specified to be damp or wet locations rated shall be UL 1598 Listed.
- G. Fixtures shall be as specified in the **Choose an item**

<b>Fixture Type</b>	<b>Fixture Wattage</b>	<b>Description</b>	<b>Basis of Design Mfr. and Model</b>
LC1	24W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 5000K, 90 CRI, clear deep frosted acrylic lens, wide distribution, gasketed fiberglass housing, polycarbonate latches, 4ft, 4000 lumen minimum, and wet location Listed.	Holophane EMS LED Series, or Engineer approved equal.

7/21/2024



Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
EW1	2-11W (heads) 13W (battery)	Wall-mounted emergency fixture, LED heads, 120-277 VAC with 12 VDC lithium iron phosphate or nickel cadmium battery, gray corrosion and impact resistant polycarbonate housing surge and brown-out protection, and low voltage battery cut-off. NEMA 4X wet location Listed. Battery shall be sized to support the fixture and all remote heads as shown on Drawings.	Holophane Desoto DSL46, Lithonia EXTL Series, or Signify Chloride Rhino Series.
XW1	1.5W	Wall-mounted, red LED exit sign, 120-277VAC, brushed aluminum faceplate, die cast aluminum housing, single/double face as indicated on the drawings, nickel cadmium battery with self-diagnostics, brownout and surge protected, damp location Listed.	Holophane Magellan MEX Series, Lithonia LE Series, or Current Dual-lite SE Series.

### 2.03 LED DRIVERS

- A. Drivers shall have a voltage range of 347-480V or 120-277 (as required) +/- 10% at a frequency 60Hz.
- B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.
- C. Case temperature shall be rated for -40°C through +80°C.
- D. Drivers shall have overheat protection, self-limited short circuit protection and overload protected.
- E. Drivers shall be furnished with a fused primary.
- F. Drivers shall have an output current ripple <30%
- G. Drivers shall be manufactured by Philips, Advance, Universal or equal.
- H. Drivers shall be UL Listed for damp location, UL1012, ROHS.
- I. Drivers shall meet FCC 47 Sub Part 15.
- J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

**2.04 LEDES**

- A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.
- B. Color Temperature: as specified in fixture schedule.
- C. Junction point shall be designed and manufactured to allow adequate heat dissipation.
- D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

**PART 3 – EXECUTION****3.01 INSTALLATION**

- A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.
- B. The Contractor shall provide and install all inserts, conduit, structural supports as required, mounting, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit connected to an outlet box where necessary or required resulting in a neat and complete installation.
- C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, etc.
- D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be onepiece, with matching canopies and fittings.

- E. All wiring/cables associated with lighting equipment shall be installed in conduits or other raceways as specified. Installing wiring/cables exposed is not acceptable, unless specifically shown otherwise on the Drawings.
- F. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.
- G. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.
- H. All lighting fixtures, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.
- I. The Contractor shall support each fixture securely. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all members and supports as required to fasten and suspend fixtures from the structure.
- J. In all mechanical equipment areas, the Contractor shall install lighting fixtures after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.
- K. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures as directed.
- L. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
  - 1. Certified Shop Tests
    - a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.
  - 2. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

**END OF SECTION**

**SECTION 28 46 20**  
**FIRE ALARM SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. Furnish and install a complete addressable Fire Alarm System including control panel, annunciator, alarm initiating and indicating devices, conduit, wiring, and other components as required for a complete and operational system. A fire alarm system shall be installed under this Contract at the Dewatering Building as noted on the Drawings. System shall be in conformance with the latest NFPA and UL Standards listed below. Furnish installation drawings, tools, and all labor required to complete the work as specified herein and indicated on the Drawings.
- B. This is a performance specification. The Contractor shall hire a licensed Professional Engineer, certified in fire protection in the State or Commonwealth in which the project is located, to review the requirements of this Section and design a fire alarm system in accordance with all applicable standards and current Building Code of the State or Commonwealth in which the project is located. The Contractor shall submit the Drawings to the local Authorities having jurisdiction as described herein and coordinate the approval process. The Contractor shall make any changes necessary and install any additional components required in order to receive approval, at no additional cost to the Owner. A fire alarm system design is not shown on the Drawings.
- C. System shall be capable of being monitored by both a central station monitoring system as well as the Owner's local SCADA system.
- D. The Contractor shall include in their bid all costs for the fire alarm system, as well as all of the necessary conduit, wire, supports, installation, etc.
- E. Some components of the fire alarm system may be installed in NEC Article 501 hazardous areas. Reference Electrical Drawings for the extents of all hazardous areas.
- F. All components used for the fire alarm system shall be suitable for the area in which they are installed. Fire alarm system design shall utilize appropriate components (e.g. weatherproof devices, explosion-proof devices, etc.) as required, even if required components are not specifically indicated within Part 2 – Products herein.
- G. Reference Section 26 05 00 – Basic Electrical Requirements, Section 26 05 33.13 – Conduit for Electrical Systems, Section 26 05 19 – Low-Voltage Conductors and Cables, and Section 26 05 53 – Identification for Electrical Systems.

## 1.02 CODES AND STANDARDS

- A. The system shall comply with all Federal, State/Commonwealth, and County laws or ordinances, as well as all applicable codes, standards, regulations, and/or regulatory agency requirements including the partial listing below:
  - 1. National Fire Protection Association (NFPA) Publications
    - a. NFPA 71
    - b. NFPA 72
    - c. NFPA 90A
    - d. NFPA 101
  - 2. Underwriter's Laboratories (UL), Inc.
  - 3. Factory Mutual (FM) System
  - 4. National Electrical Code, Article 760

## 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Division 01 the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts List
  - 4. Manufacturer's Field Start-up Report
  - 5. Manufacturer's Representative's Certification
- B. Each submittal shall be identified by the applicable Specification Section.

## 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submissions will be returned to the Contractor without review for re-submittal.

- C. Shop drawings for each system shall include but not be limited to:
1. Control panel interior wiring diagrams, point-to-point wiring diagram showing the point of connection and terminal used for all electrical field connections in the system and field wiring color-coded scheme.
  2. Descriptive bulletins and product data sheets for all alarm indicating and initiating devices in sufficient detail to permit comparison with the specifications inclusive of: manufacturer's literature, illustrations, specifications, materials of construction, related engineering, data and compliance with NFPA, FM, UL, and local standards.
  3. A complete list identifying each addressable initiating device custom label, annunciator zone, notification appliance signaling zone, remote signaling and auxiliary function zone and the specific devices associated with each zone.
  4. An input/output matrix defining the system operation. This matrix shall cross-reference each initiating device to its corresponding annunciator zones, notification appliance signaling zones, remote signaling zones and auxiliary function zones and indicate system operation in the event of each type of trouble condition recognized by the system. This matrix shall be in the format as shown in NFPA 72.
  5. Power supply, standby battery, battery charger and NAC voltage drop calculations for each power supply, configuration of standby batteries in the system, identifying both the non-alarm and alarm load associated with each, and demonstrating conformance to the requirements of these specifications relative to sizing/capacity of power supplies ,chargers, and standby batteries as applicable.
  6. Assembly and installation drawings.
  7. Spare parts list.
  8. Manufacturer's warranty statement.
  9. Sample central station monitoring contract for Owner review.
  10. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten

explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

- D. Submit drawings, calculations and system component data sheets as listed in the paragraphs above for approval to the City of Marriot-Slaterville, Owners Insurance Underwriter, and any other Authorities Having Jurisdiction. Drawings and calculations shall be signed and sealed by the licensed Professional Engineer certified in fire protection in the State or Commonwealth in which the project is located.
- E. Submit evidence that the equipment furnished complies with NFPA standards and satisfies all local codes for buildings in the appropriate Use Group as indicated on the building code sheets (General Drawings).
- F. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.
- G. If standard data and catalog literature is supplied, all furnished options shall be carefully highlighted and options not being furnished shall be carefully deleted with 'strikethrough' notations. Unclear information will cause rejection of the entire submittal.

#### **1.05 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall submit Operation and Maintenance manuals in accordance with the procedures and requirements set forth in Division 01. The manuals shall include:
  - 1. Instruction books, descriptive bulletins, technical bulletins, application data booklets, and other applicable instructional information.
  - 2. Recommended spare parts list.
  - 3. Final as-built construction drawings included in the shop drawings incorporating all changes made during the completion of the project.

#### **1.06 SPARE PARTS**

- A. The fire alarm system shall be furnished with all spare parts as recommended by the equipment manufacturer. Spare parts shall be furnished in accordance with Division 01.
- B. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following minimum spare parts:



No. Required	Description
5% (minimum of 1)	Each type of heat detector and smoke detector including base
5% (minimum of 1)	Each type of manual pull station and each type notification appliance

- C. The spare parts shall be packed in containers suitable for long-term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.
- E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.
- G. Spare parts shall be identical and interchangeable with corresponding parts of installed system.

**1.07 IDENTIFICATION**

- A. Each system component shall be identified with a unique identification number. A nameplate shall be securely affixed in a conspicuous place on each device. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.
- B. Fire alarm terminal and junction boxes shall be identified in accordance with Article 760 of the NEC, and painted red and stenciled "FIRE ALARM" preventing unintentional interference with the signaling circuits during testing, servicing and additional modifications to the system.
- C. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item.
- D. Keys and locks shall be furnished with tags bearing stamped identification numbers. Cable and conduit runs shall be identified in accordance with Section 26 05 33.13 – Conduit for Electrical Systems and Section 26 05 19 – Low-Voltage Conductors and Cables.

## 1.08 QUALIFICATIONS OF INSTALLER

- A. Prior to installation, the Contractor shall submit data proving that they have successfully installed fire alarm systems of the same type and design as specified herein. Submit the names and locations of at least two installations where such systems have been installed. The Contractor shall indicate the type and design of these systems and certify that these systems have performed satisfactorily.

## PART 2 – PRODUCTS

### 2.01 MANUFACTURERS

- A. To ensure that the Fire Alarm System is integrated, coordinated and compatible system, one (1) manufacturer shall furnish all components specified herein. The system shall be as manufactured by Edwards and shall match the existing Intelligent Fire Alarm Systems installed on site.

### 2.02 FIRE ALARM SYSTEM

- A. Fire Alarm Control Panel (FACP) and Fire Alarm Annunciator Panel (FAAP)
  - 1. Provide a combination FACP and FAAP in the location shown on the drawings.
  - 2. System shall be non-coded supervised addressable initiating, with annunciators as indicated on Drawings. Each circuit shall be electrically supervised against disarrangement. Wiring shall be Class A. Each system shall be able to be wired for a minimum of 250 addressable devices.
  - 3. Control panel shall be microprocessor based and use solid-state components to operate the system. Control panel shall contain a 60 hour 24 VDC battery back-up system. Provide system reset switch, battery and alarm horn, indicating device test switches and alarm relays.
  - 4. Panel shall have the capability to accept as a minimum all alarm initiating devices as shown on the Drawings for each system. The panel shall have a 1,000 point (minimum) capacity where (1) point equals (1) monitor (input) or (1) control (output).
  - 5. Install auxiliary relays as required in the panel with a minimum of eight (8) 120 volt normally open alarm contact outputs for remote alarm annunciation. The relays shall energize when a fire alarm, trouble, or supervisory alarm occurs. Wire all relay contacts to terminal blocks for connection to field wiring.
  - 6. In the event of total power loss and restoration, the status of the initiating devices and notification appliances shall remain unchanged. The entire fire alarm system shall be powered from the battery back-up system during a power loss.

7. The panel shall have a 24 VDC power supply mounted in the panel enclosure.
8. The fire alarm system manufacturer shall provide all logic and/or programming to the fire alarm control panel so the fire alarm system will operate as follows:
  - a. When a fire alarm pull station is pulled the fire alarm system will immediately go into an alarm state and energize the alarm horns, strobe lights and the auxiliary relays for remote notification
  - b. The smoke detectors shall have an alarm verification feature to prevent nuisance alarms. In the event that a detector is activated and the alarm verification period has been exceeded, the fire alarm system shall go into an alarm state and energize the alarm horns, strobe lights and the auxiliary relay for remote notification.
9. The control panel shall also have all of the following features:
  - a. Microprocessor based control.
  - b. Factory programmed and field configurable
  - c. Alarm and trouble with 24-hour reminder.
  - d. Signal silence inhibit.
  - e. Alarm verification by device.
  - f. Alarm, trouble, supervisory and verification last event records.
  - g. One person test.
  - h. Inherently power limited per NEC Article 760.
  - i. UL Listed.
  - j. FM approved.
  - k. Dead front option for the enclosure.
  - l. Central station DACT and HVAC shutdown relays.
  - m. Hardware for central station monitoring via analog telephone line.
  - n. The control panel shall have voice annunciation capabilities. The control panel shall have a minimum of two (2) pre-recorded messages that can be activated in the event of a fire or other evacuation of the building. Buttons shall be provided for maintenance personnel to activate the pre-recorded evacuation messages.

10. Alphanumeric Display and System Controls: Panel shall include an LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
11. FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
12. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
13. Programmable Sensitivity: Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
14. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be capable of being printed for annual recording and logging of the calibration maintenance schedule.
15. The FACP shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches predetermined values, three (3) progressive levels of reporting shall be provided. The first level shall indicate if a sensor is close to a trouble reporting condition and shall be indicated on the FACP (i.e. "ALMOST DIRTY"). If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble shall be reported. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If this indicator is ignored and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the FACP.
16. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition at the FACP.

## B. Alarm Initiating Devices

1. Fire Alarm Pull Stations
  - a. Fire alarm pull stations shall comply with NFPA standards and be compatible with the Fire Alarm Control Panel.

- b. Pull stations shall be double action addressable type that require an outer door to be operated to expose actuation handle.
- c. Provide necessary control power, and any other modules required for operation integral with Fire Alarm Control Panel.
- d. Provide weatherproof pull stations in outdoor areas or indoor wet process locations. Provide pull stations suitable for use in hazardous areas when installed in hazardous areas.

## 2. Smoke Detectors

- a. Smoke Detectors shall comply with NFPA standards and shall be compatible with the Fire Alarm Control Panel.
- b. Type: Smoke sensors shall be of the photoelectric or combination photoelectric/ heat type.
- c. Spacing: In accordance with the manufacturer's recommendations and the requirements of NFPA 72, however, in no case shall spacing exceed 30 ft. by 30 ft. per detector.
- d. Proximity to Fixtures: Smoke detectors shall not be placed closer than 5 ft. from any vent entrance or discharge point.
- e. Each sensor base shall contain an LED that shall flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
- f. Sensors shall include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
- g. Each sensor shall be scanned by the FACP for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a wrong device, the control unit shall operate with the installed device at the default alarm settings for that sensor. The settings shall be 2.5% obscuration for the photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, and the FACP shall indicate a "Wrong Device" trouble condition.
- h. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
- i. Plug-In Arrangement: Sensor and associated electronic components shall be mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to

engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the FACP.

- j. Removal of the sensor head for cleaning shall not require the setting of addresses.
- k. Provide detectors suitable for use in hazardous areas when installed in hazardous areas.

### 3. Duct Smoke Detectors

- a. Duct smoke detectors shall have all the same features as a regular smoke detector except it shall be specifically designed to be installed in the supply or return ducts of the HVAC units where indicated on the HVAC Drawings. The detectors shall be rated for the size of duct in which it will be installed and the CFM of the air flow through it.
- b. Location: Required where indicated on the HVAC Drawings and where required to meet all local and national codes.
- c. Duct smoke detectors shall be furnished by the fire alarm system supplier under this Section, but shall be installed by the HVAC Subcontractor.
- d. The Duct housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
- e. Duct housing shall provide a relay control trouble indicator Yellow LED.
- f. Duct housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of captive fastening screws.
- g. Duct housing shall provide two (2) test ports for measuring airflow and for testing. These ports shall allow aerosol injection in order to test the activation of the duct smoke sensor.
- h. Each duct smoke sensor shall have a remote test station with an alarm LED and test switch.

### 4. Heat Detectors

- a. Heat detectors shall comply with NFPA standards and shall be compatible with the Fire Alarm Control Panel.

- b. Spacing: In accordance with the manufacturer's recommendations and the requirements of NFPA 72.
- c. Addressable heat detectors shall be ambient compensated combination rate-of-rise and fixed temperature type. The fixed temperature operation of the sensor shall be selectable for either 117 or 135°F. Rate-of-rise operation shall be selectable for either 15 or 20°F per minute and shall be self-restorable.
- d. Heat detectors shall be addressable and shall be of the epoxy encapsulated electronic design. Detectors shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- e. Provide detectors suitable for use in hazardous areas when installed in hazardous areas.

### C. Alarm Indicating Devices

#### 1. Fire Alarm Horns

- a. Fire alarm horns shall comply with NFPA, UL Standards, all local codes and be compatible with the Fire Alarm Control Panel.
- b. Piezoelectric type horn shall be listed to UL 464. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.
- c. Provide horns suitable for use in hazardous areas when installed in hazardous areas.

#### 2. Strobe Lights

- a. Strobe Lights shall comply with NFPA, UL standards and be compatible with the Fire Alarm Control Panel.
- b. Strobe lights shall have the words "FIRE" on it and comply with NFPA.
- c. Strobe shall be listed to UL 1971. The strobe shall consist of a xenon flash tube and associated lens/reflector system. The strobe enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. strobe appliances shall be provided with different minimum flash intensities of 15cd, 30cd, 75cd and 110cd. Candela intensity shall be field adjustable. Provide an indicator inside the strobe lens to indicate the listed candela rating of the specific strobe appliance.

- d. Provide units suitable for use in hazardous areas when installed in hazardous areas.
3. Audible/Visible Devices
    - a. Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. A/V appliances shall be provided with different minimum flash intensities of 15cd, 30cd, 75cd and 110cd. Candela intensity shall be field adjustable. Provide an indicator inside the strobe lens to indicate the listed candela rating of the specific A/V appliance. The audible device shall meet the requirements of the audible devices previously described. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.
    - b. Provide units suitable for use in hazardous areas when installed in hazardous areas.
- D. System Addressable Interface Devices
1. Control Module, (addressable relay) - The control modules shall be programmable by the FACP and installed where required. The control module shall be a line powered module and relay contact shall be capable of switching up to 2A @ 30 Vdc.
  2. Monitor Module (addressable input) - The monitor modules shall be installed where required and monitor normally open contacts and shall be programmed for a variety of input types as defined in the system programming.
- E. Power Requirements
1. Power supply to all components of the system shall be as required, furnished and installed by the Contractor.
  2. Booster power supplies shall be furnished and installed where required.
- F. Fire Alarm Control Panel Cellular Interface
1. The Fire Alarm Control Panel Cellular Interface shall provide access to a Remote Supervising Station for monitoring of system alarms, troubles, and supervisory conditions as required and approved by the local AHJ and shall transmit those signals from the fire panel over the digital cellular network to the designated monitoring station.
  2. Unit shall meet UL 864 requirements for sole, primary, or backup path communications and shall support virtually all alarm formats for universal panel



compatibility and shall serve as the sole communications path for the fire alarm system, replacing any of the landlines normally dedicated to the fire alarm control unit.

3. The unit shall provide multi-tower assessment to inform the installer if the unit can see multiple cell towers for redundancy. It shall also include SMS backup to reduce false alarms and provide self-tests using SMS if GPRS fails. Automatic self-tests of 5 minutes and daily with central monitoring station notification shall ensure the cellular system is operating and an available relay output for tripping the alarm control panel when a trouble condition occurs shall be provided.
4. Power for the unit shall be via a UL listed plug-in transformer rated 12VAC, 800mA. Cellular transmit power shall be 1.0W-2.0W and unit power consumption shall be 60mA standby and 250mA transmission. The radio transceiver shall be dual band cellular and PCS with GSM frequency and power of 850MHz: Class 4 (2 watts) and additional GSM frequency and power of 1900MHz: Class 1 (1 watt). Provide an externally mountable antenna. Antenna shall be 9" dipole with 2dBi gain with 20 ft. of cable and universal mounting bracket. Unit shall be registered under FCC part 15, 22, 24 and 68 compliant.
5. The unit shall be furnished in a wall-mounted, locking, red metal enclosure. Operating Environment shall be 32°F to 120°F; up to 95% humidity (non-condensing). An internal power supply with battery harness and backup batteries shall be provided. Two programmable supervisory trip outputs shall be provided with alarm format support for SIA2, Contact I D, pulse (3x1, 4x2), modem II e, & III a2, and DMP.
6. Unit shall be a TG-7FS as manufactured by Telguard, or Engineer approved equal.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. The fire alarm system shall be furnished and installed as noted on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. System and Control Wiring
  1. All system wiring shall be furnished and installed by the Contractor. All wiring shall be installed in conduit in accordance with Section 26 05 33.13 – Conduit for Electrical Systems. System wiring shall be installed separate from all other building wiring.

2. All system components shall be securely supported independent of the wiring. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, installed parallel and perpendicular to walls and partitions.
  3. The sizes of the conductors shall be those specified by the manufacturer. Color coded wire shall be used. All wires shall be tagged at all junction points and shall be free from short circuits, earth connections (unless so noted on the system drawings), and crosses between conductors. Final terminations between the FACP and the system field devices shall be made under the direct supervision of a factory trained representative.
  4. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 725, and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72 latest edition.
  5. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electrical Code.
- C. Mount the Fire Alarm Control Panel such that the height of the top operating handle or knob does not exceed 6 ft. from the floor.
- D. After completion of the installation, the Contractor shall clean the inside and the outside of the fire alarm system equipment and shall remove all dirt and debris from the site.

### **3.02 TESTING**

- A. All tests shall be performed in accordance with the requirements of the General Requirements and Division 01. The following tests are required:
1. Witnessed Shop Tests
    - a. None required.
  2. Certified Shop Tests and Reports
    - a. Submit description of proposed testing methods, procedures, and apparatus.
    - b. Submit certified copies of all factory test reports.
  3. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01 and the requirements of all applicable codes and standards.
    - b. Reference Section 26 05 00 – Basic Electrical Requirements.

- c. All tests shall be performed in the presence of the Engineer and Owner. The Contractor shall notify the Engineer at least 14 days before the performance and acceptance tests are to be conducted. A complete test report and letter of completion shall be submitted to the Engineer. The tests shall be performed by, or under the supervision of a qualified representative of the fire alarm system manufacturer and shall include the following:
  - 1) Verify that the system is free of grounds or open circuits. The FACP shall indicate when a ground or an open circuit exists.
  - 2) Verify that all alarm signal devices, stations, transmitters, automatic detectors, and supervisory devices are functioning as specified.
  - 3) Test each fire alarm device and circuit. Individually activate each manual initiating station and verify correct alarm operation and control panel response. Individually test each automatic initiating device and verify correct alarm operation, control panel response, and remote equipment operation.
  - 4) Test battery backup systems for specified function and capacity.
- d. The Contractor and the installer shall contact the local Building Department for final approval of the system and demonstrate the system to the Fire Department for approval.
- e. If approval is denied by the Fire Department, then the installer shall make any changes necessary, at no additional cost to the Owner, to get approval as part of this scope. After any modifications have been made, if necessary, the installer shall demonstrate the system again to the Fire Department in order to get approval.
- f. Coordinate testing of fire alarm system with fire suppression system testing.
- g. Upon acceptance by the Owner, the completed system(s) shall be placed into service.

### **3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE**

- A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of the equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.

- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall not take place until after the motor controllers have been installed and tested. Training shall be conducted at times coordinated with the Owner.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
  - 1. One (1) trip of two (2) working days during installation of the fire alarm system.
  - 2. One (1) trip of two (2) working days to perform field acceptance testing of the fire alarm system.
  - 3. One (1) trip of one (1) working day two (2) months before the warranty expiration to identify any issues to be corrected under warranty.
  - 4. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

### **3.04 MANUFACTURER'S CERTIFICATION**

- A. A qualified, factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.

**END OF SECTION**

**SECTION 40 61 13**  
**PROCESS CONTROL SYSTEM GENERAL PROVISIONS**

**PART 1 – GENERAL**

**1.01 SCOPE**

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, components, system installation services, as well as required and specified ancillary services in connection with the Instrumentation, Control and Information System.
- B. The System includes materials, labor, tools, fees, charges, and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system.
- C. The system shall include measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring, and pertinent accessories.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
  - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
  - 2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
  - 3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Sections 40 60 00 through 40 79 99, inclusive and where included.
  - 4. Furnish and install digital control system hardware and software as specified in Sections 40 60 00 through 40 79 99, inclusive and where included.
  - 5. Final termination and testing of instrumentation and control system signal wiring and power supply wiring at equipment furnished under Sections 40 60 00 through 40 79 99, inclusive and where included.

6. Furnish, install and terminate special cables for devices (e.g., instruments, printers, radios). Furnish and terminate control system communication network cables.
  7. Furnish and install surge protection devices for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 26.
  8. Coordinate grounding requirements with the electrical subcontractor for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division. Terminate grounding system cables at equipment provided under this Division.
  9. Provide system testing, calibration, training and startup services as specified herein and as required to make systems fully operational.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.
- F. It is the intent of the Contract Documents for the instrumentation and control system subcontractor to provide all controls and programming associated with the new HVAC system. Refer to Specification Section 23 09 00 - HVAC Automatic Temperature Controls for additional requirements associated with the HVAC system controls.

## 1.02 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls, and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested, and calibrated as specified under other Divisions unless otherwise indicated.
- B. Additional and related work performed under Division 26 includes the following:
1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for equipment, control panels and accessories furnished under Sections 40 60 00 through 40 79 99, inclusive and where included.
  2. Conduit and raceways for instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.
  3. Instrumentation and control system signal wiring.

4. Install control system communication network cables.
5. Furnish and install grounding systems for digital equipment, local control panels, remote telemetry units, and instrumentation provided under Sections 40 60 00 through 40 79 99, inclusive and where included. Grounding systems shall be complete to the equipment provided under Sections 40 60 00 through 40 79 99, inclusive, and where included, ready for termination by the instrumentation subcontractor.
6. Termination of instrumentation and control system signal wiring at equipment furnished under other Divisions of the Specifications.
7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g., panelboards, motor control centers, and other sources of electrical power).

### **1.03 GENERAL INFORMATION AND DESCRIPTION**

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.
- B. In order to centralize responsibility, it is required that equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating signals, and furnishing appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment/systems and shall provide for the services of a qualified installation engineer to supervise activities required to place the completed facility in stable operation under full digital control.
- D. The instrumentation and control system shall be capable of simultaneously implementing all real time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of other system components.

- E. Control system inputs and outputs are listed in Section 40 61 93 – Process Control System Input/Output List. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.
- F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect equipment, panels, instrumentation, controls, and appurtenances, either existing or furnished on the Project to determine requirements for interfacing with the control and information system. The Contractor shall coordinate the completion of required modifications with the associated supplier of the item furnished.
- G. The instrumentation subcontractor shall review and approve the size and routing of instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.
- I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to observe materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records, and certifications during all stages of design, fabrication, and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies, and services required for these observation activities.
- K. The terms "Instrumentation," "Instrumentation and Control System," and "Instrumentation, Control and Information System" shall hereinafter be defined as equipment, labor, services, and documents necessary to meet the intent of the Specifications.



#### 1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities, remote telemetry systems for water supply/distribution systems, and remote telemetry systems for wastewater collection systems. Instrumentation and control system subcontractors shall have a minimum of five years of such experience and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers/models of major hardware or software products (PLC, HMI software, network, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made.
- B. Acceptable instrumentation and control system subcontractors shall be SKM Engineering, no equal. Contact:

SKM Engineering  
Mark Jeppsen, PE  
[mark.jeppsen@skmeng.com](mailto:mark.jeppsen@skmeng.com)  
801-677-0011

#### 1.05 DEFINITIONS

- A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.
- B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.
- C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

- D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.
- E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.
- F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (\text{MTBF} / (\text{MTBF} + \text{MTTR})) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1 - A1) * (1 - A1))$$

where:

A1 = availability of non-redundant device or system

A2 = availability of device or system provided with an automatically switched backup device or system

- G. Abbreviations: Specification abbreviations include the following:
1. A - Availability
  2. ADC - Analog to Digital Converter
  3. AI - Analog Input
  4. AO - Analog Output
  5. AVAIL - Available
  6. BCD - Binary Coded Decimal
  7. CSMA/CD - Carrier Sense Multiple Access/Collision Detect
  8. CPU - Central Processing Unit
  9. CRC - Cyclic Redundancy Check

10. CS - Control Strategy
11. DAC - Digital to Analog Converter
12. DBMS - Data Base Management System
13. DI - Discrete Input
14. DMA - Direct Memory Access
15. DO - Discrete Output
16. DPDT - Double Pole, Double Throw
17. DVE - Digital to Video Electronics
18. EPROM - Erasable, Programmable Read Only Memory
19. FDM - Frequency Division Multiplexing
20. FSK - Frequency Shift Keyed
21. HMI - Human Machine Interface (Software)
22. I/O - Input/Output
23. LAN - Network and Communication Equipment
24. LCD - Liquid Crystal Display
25. LDFW - Lead Follow
26. MCC - Motor Control Center
27. MTBF - Mean Time Between Failures
28. MTTR - Mean Time to Repair
29. OS - Operating System
30. PAC - Programmable Automation Controller
31. PCB - Printed Circuit Board
32. PID - Proportional Integral and Derivative Control

33. PLC - Programmable Logic Controller or Programmable Controller
  34. PROM - Programmable Read Only Memory
  35. RAM - Random Access Memory
  36. RDY - Ready
  37. RMSS - Root Mean Square Summation
  38. RNG - Running
  39. ROM - Read Only Memory
  40. RTU - Remote Telemetry Unit
  41. SPDT - Single Pole, Double Throw
  42. ST/SP - Start/Stop
  43. TDM - Time Division Multiplexing
  44. UPS - Uninterruptible Power Supply
  45. VFD - Variable Frequency Drive
- H. To minimize the number of characters in words used in textual descriptions on displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

## **1.06 ENVIRONMENTAL CONDITIONS**

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (e.g., dust).

- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION**

### **3.01 SCHEDULE OF PAYMENT**

- A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.
- B. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory witness test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.
- C. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

### **3.02 CLEANING**

- A. The Contractor shall thoroughly clean soiled surfaces of installed equipment and materials.
- B. Upon completion of the instrumentation and control work, the Contractor shall remove surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

### **3.03 FINAL ACCEPTANCE**

- A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:
  - 1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.
  - 2. Completion of the Availability Demonstration.
  - 3. Completion of control system training requirements.
  - 4. Completion of punch-list items that are significant in the opinion of the Engineer.
- B. Final acceptance of the System shall mark the beginning of the warranty period.

**END OF SECTION**

**SECTION 40 61 15**  
**PROCESS CONTROL SYSTEM SUBMITTALS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General and Supplemental Conditions and Division 01 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.
- B. All submittal materials shall be tailored to this project by highlighting relevant items or crossing out non-applicable items. Generic submittals without identified options will be returned the Contractor without review.
- C. Compliance, Deviations, and Exceptions (CD&E) Letter:
  - 1. Where a named manufacturer and product is specified and a substitution or an “or equal” product is submitted, the submittal shall be accompanied by a “Compliance, Deviations, and Exceptions (CD&E) letter.” If the required submittal is submitted without the letter, the submittal will be rejected.
  - 2. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor, subcontractor (if applicable), and the equipment Manufacturer/Supplier. This letter shall include a copy of the Specification Section to which the submittal pertains. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in.
    - a. The letter "C" shall be for full compliance with the requirement.
    - b. The letter "D" shall be for a deviation from the requirement.
    - c. The letter "E" shall be for taking exception to a requirement.
  - 3. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions shall not be acceptable.
  - 4. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01 33 00 – Submittal Procedures
- B. Section 40 61 13 – Process Control System General Provisions

**1.03 DIGITAL HARDWARE SUBMITTALS**

- A. Submit system block diagram(s) showing:
  - 1. All equipment to be provided.
  - 2. All interconnecting cable.
  - 3. Equipment names, manufacturer, and model numbers.
  - 4. Equipment locations.
- B. Submit information for all digital equipment including, but not limited to, the following:
  - 1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
  - 2. Catalog cuts, including complete part number breakdown information.
  - 3. Complete technical, material and environmental specifications.
  - 4. Assembly drawings.
  - 5. Mounting requirements.
  - 6. Color samples.
  - 7. Nameplates.
  - 8. Environmental requirements during storage and operation.

**1.04 SOFTWARE SUBMITTALS**

- A. Software submittals shall include the following as a minimum:
  - 1. Bill of materials with software names, vendors, and complete listings of included software modules.
  - 2. Standard manufacturer's literature describing the products.
  - 3. Description of function of software in Control and Information System.



4. Limitations or constraints of software.
  5. Minimum system (processor and memory) requirements.
  6. Operation and maintenance requirements.
- B. Submit information on the following software:
1. Third-party software, including:
    - a. Operating system.
    - b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).
    - c. Office-type products, such as spreadsheets, word processors, etc.
    - d. Database management software.
    - e. Communication software, including all applicable local and wide area network software.
    - f. Programmable controller programming software (where applicable).
  2. Software configuration, including:
    - a. Graphic display organization.
    - b. Database configuration for operator workstations and database management system.
    - c. Trends.
    - d. System security.
    - e. Formats for all reports, including all required calculations.
    - f. Intercommunications between software products required to implement system functions.
    - g. Equipment backup configuration and requirements.
- C. Control Strategies
1. Description of automatic logic and all non-standard manual logic using plain English, for non-technical persons, and written in Contractor's own words. The

write-up shall include references to associated I/O, tag/loop numbers, alarming/interlocks.

#### D. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

#### E. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.
2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.
3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters and is intended to allow the Contractor to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.
4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.
5. The required submittals in each revision cycle shall be full color prints of the entire set of displays.
6. Displays shall be printouts of actual process graphics implemented in the system.

### 1.05 CONTROL PANEL SUBMITTALS

A. Submittals shall be provided for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.

2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
  3. Panel area reserved for cable access and conduit entry.
  4. Location plans showing each panel in its assigned location.
- B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:
1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
  2. Catalog cuts, including complete part number breakdown information.
  3. Complete technical, material and environmental specifications.
  4. Assembly drawings.
  5. Mounting requirements.
  6. Color samples.
  7. Nameplates.
  8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

#### **1.06 INSTRUMENT SUBMITTALS**

- A. Submit information on all field instruments, including but not limited to the following:
1. Product (item) name and tag number used herein and on the Contract Drawings.
  2. Catalog cuts, including complete part number breakdown information.
  3. Manufacturer's complete model number.
  4. Location of the device.
  5. Input output characteristics.
  6. Range, size, and graduations.

7. Physical size with dimensions, NEMA enclosure classification, and mounting details.
8. Materials of construction of all enclosures, wetted parts and major components.
9. Instrument or control device sizing calculations where applicable.
10. Certified calibration data on all flow metering devices.
11. Environmental requirements during storage and operation.
12. Associated surge protection devices.
13. Installation drawings/details.

#### **1.07 WIRING AND LOOP DIAGRAMS**

- A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.
- B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.
- C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required Items
- D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

#### **1.08 OPERATION AND MAINTENANCE MANUALS**

- A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01 33 00 – Submittal Procedures. Operation and maintenance (O&M) manuals shall consist of two basic parts:
  1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
  2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.
1. A comprehensive index.
  2. A functional description of the entire system, with references to drawings and instructions.
  3. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
  4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
  5. Full specifications on each item.
  6. Detailed service, maintenance, and operation instructions for each item supplied.
  7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
  8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
  9. References to manufacturers' standard literature where applicable.
  10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- D. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in

terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
  - 1. Operation Information: This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
  - 2. Preventive Maintenance Instructions: These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.
  - 3. Corrective Maintenance Instructions: These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
  - 4. Parts Information: This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.
- G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:
  - 1. A program abstract that includes:
    - a. Program Name - The symbolic alphanumeric program name.
    - b. Program Title - English text identification.
    - c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by non-programming-oriented readers.

2. A program description that shall include, but not be limited to, the following:
  - a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
  - b. Input Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
  - c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.
  - d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.
  - e. Limitations and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.
  - f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.
  - g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.
  - h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.
  - i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

### **1.09 FINAL SYSTEM DOCUMENTATION**

- A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.
- C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.
- D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

### **1.10 PROGRAMS AND SOURCE LISTINGS**

- A. Provide one copy of all standard, off-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.
- B. Provide one copy of source listings on digital media, acceptable to Engineer, for all custom software/logic written specifically for this facility, all database files configured for



this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

- C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

#### **1.11 SUBMITTAL/DOCUMENTATION FORMAT**

- A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.
- B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in searchable Adobe Portable Document Format (PDF). Raster scans will not be accepted.

#### **1.12 ELECTRONIC O&M MANUALS**

- A. Subject to acceptance by the Engineer, the O&M information may be submitted in part or in whole in an electronic format on digital media.
- B. Electronic O&M manuals shall contain information in standard formats (searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible using standard, "off-the-shelf" software such as an Internet browser. Raster scans will not be accepted.

### **PART 2 – PRODUCTS (NOT USED)**

### **PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 40 61 21**  
**PROCESS CONTROL SYSTEM TESTING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 21.71 – Factory Witness Test
- C. Section 40 61 21.72 – Field Testing
- D. Section 40 61 21.73 – Final Acceptance Test

**1.03 SUBMITTALS**

- A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:
  - 1. A schedule of all testing to be conducted.
  - 2. A brief description of the testing to be performed
  - 3. Test objectives.
  - 4. Testing criteria per the Specifications.
  - 5. Check lists and procedures for performing each of the specified tests.
  - 6. Sample test result documentation.
  - 7. Requirements for other parties.

**1.04 GENERAL REQUIREMENTS**

- A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21

days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

- B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.
- C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.
- D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.
- E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.
- F. All testing shall include time for unstructured testing where Owner and Engineer shall have access to the equipment for testing previously undefined normal and abnormal aspects, situations, and functions. Contractor or his/her designee shall provide assistance during this time, including but not limited to documenting the unstructured testing. Owner's and Engineer's unstructured testing scenarios may not be available prior to the testing period.
- G. If, in the Engineer's or Owner's opinion, Contractor is not ready for witness testing and Engineer is present, Contractor shall reimburse Owner for Engineer's labor to attend the test. Witness testing shall then be rescheduled, with sufficient notice. In the event that Engineer has traveled, even if only to the project-site, for the testing, Engineer's travel costs shall also be reimbursed. In the event that the Owner has traveled for the testing, Owner's travel costs shall also be reimbursed.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 40 61 21.71**  
**FACTORY WITNESS TEST**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall perform a Factory Witness Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 21 – Process Control System Testing
- C. Section 40 61 21.72 – Field Testing
- D. Section 40 61 21.73 – Final Acceptance Test

**1.03 FACTORY WITNESS TEST**

- A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.
- B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.
- C. Each subsystem shall be fully factory tested for function and operation.
- D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.
- E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.
- F. The instrumentation subcontractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.

- G. The factory testing shall demonstrate all aspects of system sizing and timing including:
1. Monitoring and control scan times at the PLC level.
  2. Response times at the operator workstation level.
- H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.
- I. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:
1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.
  2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.
  3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.
  4. The system shall be operated with data input/output with the PLCs and associated panels to prove operation of all workstation functions.
  5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).
- J. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLCs. This shall include the following:
1. On-line and off-line diagnostics.
  2. For redundant units, fail-over operation and reconfiguration.

3. System initialization and restart.
  4. Network communications, including fieldbus communications where required.
  5. Non-volatility of memory.
  6. Operation of all control logic shall be demonstrated as described herein.
- K. Process I/O Simulation - Process input/output simulation for PLCs shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:
1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLCs and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.
  2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.
  3. To provide data for use at all levels of the control system at the time of system integration.
- L. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**



**SECTION 40 61 21.72**  
**FIELD TESTING**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 21 – Process Control System Testing
- C. Section 40 61 21.71 – Factory Witness Test
- D. Section 40 61 21.73 – Final Acceptance Test
- E. Section 40 70 00 – Instrumentation for Process Systems

**1.03 GENERAL REQUIREMENTS**

- A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
  - 1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Section 40 70 00 – Instrumentation for Process Systems.
  - 2. Each final control element shall be individually tested as specified hereinafter.
  - 3. Each control loop shall be tested as specified hereinafter.
  - 4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
  - 5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.
- B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

- C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

#### **1.04 CONTRACTOR'S RESPONSIBILITIES**

- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.
- C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.
- D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

#### **1.05 FINAL CONTROL ELEMENT TESTING**

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFDs, that require turndown limits shall be initially set during this test.
- C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

**1.06 LOOP CHECKOUT**

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.
- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.
- C. The accuracy of all DACs shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADCs shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.
- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

**1.07 CONTROL SYSTEM STARTUP AND TESTING**

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for

tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

- F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.
- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
- H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

#### **1.08 FACILITY STARTUP COORDINATION**

- A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
- B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.
- C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.
- D. At least one qualified control systems technician shall be provided for control system startup and test activities and at least two when loop checkout is being performed.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 40 61 21.73**  
**FINAL ACCEPTANCE TEST**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 21 – Process Control System Testing
- C. Section 40 61 21.71 – Factory Witness Test
- D. Section 40 61 21.72 – Field Testing

**1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE**

- A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner shall be given two (2) weeks' notice of the starting date of the 30-day availability test.
- B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.
  - 1. Downtime of any network-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.
  - 2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.
  - 3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.

4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:
    - a. Hard disc (one day)
    - b. Workstations (one day)
    - c. Communication interfaces (eight hours)
    - d. Printer (three days)
    - e. Process control system networks (eight hours)
    - f. Off-line (optical, etc.) storage units (one day)
    - g. UPS unit (one day)
  5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.
  6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.
  7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.
  8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.
- C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 30-day period following the restart.
- D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

## **PART 2 – PRODUCTS (NOT USED)**

## **PART 3 – EXECUTION (NOT USED)**

### **END OF SECTION**

**SECTION 40 61 23**  
**SIGNAL COORDINATION REQUIREMENTS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall conform to the signal coordination requirements specified herein.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor, and the instrumentation subcontractor.
- C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLCs and Control System PLCs.
- D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLCs, the Control System, etc.

**1.02 ANALOG SIGNAL TRANSMISSION**

- A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 VDC.
- B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
- C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.
- D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.
- E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliamperes signal.
- F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.



- G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.
- H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

### **1.03 DISCRETE INPUTS**

- A. All discrete inputs to equipment and Control and Information System PLCs, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLCs, unless specified otherwise.
- B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC

### **1.04 DISCRETE OUTPUTS**

- A. All discrete outputs from local control panels and Control and Information System PLCs to field devices, starters, panels, etc., shall be 24 VDC powered (sourced) from PLC's [dry contact relay outputs].
- B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.
- C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.
- D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

### **1.05 OTHER DISCRETE SIGNALS**

- A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

- B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.
- C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.
- D. The above requirements shall apply to all starters and panels, regardless of supplier.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 40 61 91**  
**PROCESS CONTROL SYSTEM INSTRUMENT LIST**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 90 – Schedules and Control Descriptions, General
- B. Section 40 61 93 – Process Control System Input/Output List
- C. Section 40 61 96 – Process Control Descriptions

**PART 2 – PRODUCTS**

**2.01 NAMEPLATES**

- A. Items of equipment listed in the instrument schedule, control panels, and digital hardware items shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.
- D. Submit sample nameplate of each type.

**PART 3 – INSTRUMENT SCHEDULE**

**Flow Switches (Thermal) – Section 40 71 79.16**

Tag Number	Service Description	State/Span	Remarks
FSL-H0612	EF-DW-001 PUMP ROOM EXHAUST FAN		
FSL-H0631	EF-DW-002 BELT PRESS 1 EXHAUST FAN		
FSL-H0632	EF-DW-003 BELT PRESS 2 EXHAUST FAN		
FSL-H0633	EF-DW-004 BELT PRESS 3 EXHAUST FAN		
FSL-H0634	EF-DW-005 PRESS ROOM EXHAUST FAN		
FSL-H0681	SF-DW-003 TRUCK BAY SUPPLY FAN		
FSL-H0682	EF-DW-009 TRUCK BAY EXHAUST FAN NO. 1		
FSL-H0683	EF-DW-010 TRUCK BAY EXHAUST FAN NO. 2		
FSL-H0654	SF-DW-001/002 MAU SUPPLY FANS		
FSL-H0665	EF-DW-006/007/008 MAU EXHAUST FANS		

**Single Point Gas Monitoring Systems – Section 40 76 21**

Tag Number	Service Description	State/Span	Remarks
AE/AIT-H0623	BELT PRESS ROOM COMBUSTIBLE GAS SENSOR		
AE/AIT-H0672	TRUCK BAY COMBUSTIBLE GAS SENSOR		
AE/AIT-H0625	PRESS ROOM HYDROGEN SULFIDE SENSOR		
AE/AIT-H0673	TRUCK BAY HYDROGEN SULFIDE SENSOR		

**Ammonia Gas Monitoring Systems – Section 40 76 29**

Tag Number	Service Description	State/Span	Remarks
AE/AIT-H0624	BELT PRESS ROOM AMMONIA ANALYZER		

**Temperature Instruments – Section 40 74 00**

Tag Number	Service Description	State/Span	Remarks
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TE/TT-H0601	OUTSIDE AMBIENT TEMPERATURE ELEMENT		
TE/TT-0621	PRESS ROOM TEMPERATURE ELEMENT		
AW/AIT- 0622	PRESS ROOM HUMIDITY ELEMENT		

**END OF SECTION**

**SECTION 40 61 93  
PROCESS CONTROL SYSTEM INPUT / OUTPUT LIST**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control system inputs and outputs as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 91 – Process Control System Instrument List

**PART 2 – CONTROL SYSTEM INPUT / OUTPUT SCHEDULE**

Tag Number	Service Description	PLC/RIO	Type	Remarks
YI-H0621	Press 1 running	RIO-DW-002	NDO	
YI-H0622	Press 2 Running	RIO-DW-002	NDO	
YI-H0623	Press 3 Running	RIO-DW-002	NDO	
YA-H0600	General Alarm	RIO-DW-002	NDI	
AI-H0623	Press Room %LEL	RIO-DW-002	AI	
AI-H0624	Press Room NH3 Level	RIO-DW-002	AI	
AI-H0625	Press Room H2S Level	RIO-DW-002	AI	
AAH-H0623	Press Room LEL Alarm	RIO-DW-002	DI	
AAH-H0624	Press Room NH3 Alarm	RIO-DW-002	DI	
AAH-H0625	Press Room H2S Alarm	RIO-DW-002	DI	
AI-H0672	Truck Bay % LEL	RIO-DW-002	AI	
AI-H0673	Truck Bay H2S Level	RIO-DW-002	AI	
AAH-H0672	Truck Bay LEL Alarm	RIO-DW-002	DI	
AAH-H0673	Truck Bay H2S Alarm	RIO-DW-002	DI	
FAL-H0631	Belt Press 1 Exhaust Fan Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0632	Belt Press 2 Exhaust Fan Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0633	Belt Press 3 Exhaust Fan Low Air Flow Alarm	RIO-DW-002	DI	

Tag Number	Service Description	PLC/RIO	Type	Remarks
FAL-H0682	Truck Bay Exhaust Fan 1 Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0683	Truck Bay Exhaust Fan 2 Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0634	Press Room Exhaust Fan Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0612	Pump Room Exhaust Fan Low Air Flow Alarm	RIO-DW-002	DI	
FAL-H0681	Truck Bay Supply Fan Low Air Flow Alarm	RIO-DW-002	DI	
YC-H0631	Belt Press 1 Exhaust Fan Run Command	RIO-DW-002	NDO	
YI-H0631	Belt Press 1 Exhaust Fan Running	RIO-DW-002	NDI	
YA-H0631	Belt Press 1 Exhaust Fan Fault	RIO-DW-002	NDI	
HS-H0631	Belt Press 1 Exhaust Fan in Auto	RIO-DW-002	NDI	
YC-H0632	Belt Press 2 Exhaust Fan Run Command	RIO-DW-002	NDO	
YI-H0632	Belt Press 2 Exhaust Fan Running	RIO-DW-002	NDI	
YA-H0632	Belt Press 2 Exhaust Fan Fault	RIO-DW-002	NDI	
HS-H0632	Belt Press 2 Exhaust Fan In Auto	RIO-DW-002	NDI	
YC-H0633	Belt Press 3 Exhaust Fan Run Command	RIO-DW-002	NDO	
YI-H0633	Belt Press 3 Exhaust Fan Running	RIO-DW-002	NDI	
YA-H0633	Belt Press 3 Exhaust Fan Fault	RIO-DW-002	NDI	
HS-H0633	Belt Press 3 Exhaust Fan In Auto	RIO-DW-002	NDI	
YC-H0634	Press Room Exhaust Fan Run Command	RIO-DW-002	NDO	
YI-H0634	Press Room Exhaust Fan Running	RIO-DW-002	NDI	
YA-H0634	Press Room Exhaust Fan Fault	RIO-DW-002	NDI	
HS-H0634	Press Room Exhaust Fan In Auto	RIO-DW-002	NDI	
YC-H0612	Pump Room Exhaust Fan Run Command	RIO-DW-002	NDO	
YI-H0612	Pump Room Exhaust Fan Running	RIO-DW-002	NDI	
YA-H0612	Pump Room Exhaust Fan Fault	RIO-DW-002	NDI	
HS-H0612	Pump Room Exhaust Fan In Auto	RIO-DW-002	NDI	
YCL-H0682	Truck Bay Exhaust Fan 1 Run Command Low	RIO-DW-002	NDO	
YCH-H0682	Truck Bay Exhaust Fan 1 Run Command High	RIO-DW-002	NDO	
YI-H0682	Truck Bay Exhaust Fan 1 Running	RIO-DW-002	NDI	
YA-H0682	Truck Bay Exhaust Fan 1 Fault	RIO-DW-002	NDI	
HS-H0682	Truck Bay Exhaust Fan 1 In Auto	RIO-DW-002	NDI	

Tag Number	Service Description	PLC/RIO	Type	Remarks
YCL-H0683	Truck Bay Exhaust Fan 2 Run Command Low	RIO-DW-002	NDO	
YCH-H0683	Truck Bay Exhaust Fan 2 Run Command High	RIO-DW-002	NDO	
YI-H0683	Truck Bay Exhaust Fan 2 Running	RIO-DW-002	NDI	
YA-H0683	Truck Bay Exhaust Fan 2 Fault	RIO-DW-002	NDI	
HS-H0683	Truck Bay Exhaust Fan 2 In Auto	RIO-DW-002	NDI	
YCL-H0681	Truck Bay Supply Fan Run Command Low	RIO-DW-002	NDO	
YCH-H0681	Truck Bay Supply Fan Run Command High	RIO-DW-002	NDO	
YI-H0681	Truck Bay Supply Fan Running	RIO-DW-002	NDI	
YA-H0681	Truck Bay Supply Fan Fault	RIO-DW-002	NDI	
HS-H0681	Truck Bay Supply Fan In Auto	RIO-DW-002	NDI	
YI-H0686	Normal Mode	RIO-DW-002	NDI	
YI-H0687	Winter Mode	RIO-DW-002	NDI	
ZIO-H0641	Damper MD-DW-001 Open	RIO-DW-002	DI	
ZCO-H0641	Damper MD-DW-001 Open CMD	RIO-DW-002	DO	
ZA-H0641	Damper MD-DW-001 Failed To Open	RIO-DW-002	NDI	
ZIO-H0645	Damper MD-DW-002 Closed	RIO-DW-002	DI	
ZCO-H06345	Damper MD-DW-002 Close CMD	RIO-DW-002	DO	
ZA-H0635	Damper MD-DW-002 Failed To Close	RIO-DW-002	NDI	
ZIC-H0646	Damper MD-DW-003 Open	RIO-DW-002	DI	
ZCC-H0646	Damper MD-DW-003 Open CMD	RIO-DW-002	DO	
ZA-H0646	Damper MD-DW-003 Failed To Open	RIO-DW-002	NDI	
ZIO-H0657	Damper MD-DW-004 Open	RIO-DW-002	DI	
ZCO-H0657	Damper MD-DW-004 Open CMD	RIO-DW-002	DO	
ZA-H0657	Damper MD-DW-004 Failed To Opem	RIO-DW-002	NDI	
ZIC-H0658	Damper MD-DW-005 Closed	RIO-DW-002	DI	
ZCC-H0658	Damper MD-DW-005 Close CMD	RIO-DW-002	DO	
ZA-H0658	Damper MD-DW-005 Failed To Close	RIO-DW-002	NDI	
ZIC-H0659	Damper MD-DW-006 Open	RIO-DW-002	DI	
ZCC-H0659	Damper MD-DW-006 Open CMD	RIO-DW-002	DO	
ZA-H0659	Damper MD-DW-006 Failed To Open	RIO-DW-002	NDI	



Tag Number	Service Description	PLC/RIO	Type	Remarks
ZIC-H0664	Damper MD-DW-007 Open	RIO-DW-002	DI	
ZCC-H0664	Damper MD-DW-007 Open CMD	RIO-DW-002	DO	
ZA-H0664	Damper MD-DW-007 Failed To Open	RIO-DW-002	NDI	
PDI-H0642	Filter Differential Pressure	RIO-DW-002	AI	
TAL-H0643	Supply Air Freezing	RIO-DW-002	DI	
TI-H0644	Heat Exchanger Intake Air Temperature	RIO-DW-002	AI	
TI-H0652	Heat Exchanger Discharge Temp	RIO-DW-002	AI	
YC-H0648	MAU Supply Fan 1 Run CMD	RIO-DW-002	NDO	
YI-H0648	MAU Supply Fan 1 Running	RIO-DW-002	NDI	
YA-H0648	MAU Supply Fan 1 Fault	RIO-DW-002	NDI	
HS-H0648	MAU Supply Fan 1 In Auto	RIO-DW-002	NDI	
SC-H0648	MAU Supply Fan 1 Speed Control	RIO-DW-002	NAO	
SI-H0648	MAU Supply Fan 1 Speed Indication	RIO-DW-002	NAI	
YC-H0649	MAU Supply Fan 2 Run CMD	RIO-DW-002	NDO	
YI-H0649	MAU Supply Fan 2 Running	RIO-DW-002	NDI	
YA-H0649	MAU Supply Fan 2 Fault	RIO-DW-002	NDI	
HS-H0649	MAU Supply Fan 2 In Auto	RIO-DW-002	NDI	
SC-H0649	MAU Supply Fan 2 Speed Control	RIO-DW-002	NAO	
SI-H0649	MAU Supply Fan 2 Speed Indication	RIO-DW-002	NAI	
YC-H0661	MAU Exhaust Fan 1 Run CMD	RIO-DW-002	NDO	
YI-H0661	MAU Exhaust Fan 1 Running	RIO-DW-002	NDI	
YA-H0661	MAU Exhaust Fan 1 Fault	RIO-DW-002	NDI	
HS-H0661	MAU Exhaust Fan 1 In Auto	RIO-DW-002	NDI	
SC-H0661	MAU Exhaust Fan 1 Speed Control	RIO-DW-002	NAO	
SI-H0661	MAU Exhaust Fan 1 Speed Indication	RIO-DW-002	NAI	
YC-H0662	MAU Exhaust Fan 2 Run CMD	RIO-DW-002	NDO	
YI-H0662	MAU Exhaust Fan 2 Running	RIO-DW-002	NDI	
YA-H0662	MAU Exhaust Fan 2 Fault	RIO-DW-002	NDI	
HS-H0662	MAU Exhaust Fan 2 In Auto	RIO-DW-002	NDI	
SC-H0662	MAU Exhaust Fan 2 Speed Control	RIO-DW-002	NAO	
SI-H0662	MAU Exhaust Fan 2 Speed Indication	RIO-DW-002	NAI	
YC-H0663	MAU Exhaust Fan 3 Run CMD	RIO-DW-002	NDO	

Tag Number	Service Description	PLC/RIO	Type	Remarks
YI-H0663	MAU Exhaust Fan 3 Running	RIO-DW-002	NDI	
YA-H0663	MAU Exhaust Fan 3 Fault	RIO-DW-002	NDI	
HS-H0663	MAU Exhaust Fan 3 In Auto	RIO-DW-002	NDI	
SC-H0663	MAU Exhaust Fan 3 Speed Control	RIO-DW-002	NAO	
SI-H0663	MAU Exhaust Fan 3 Speed Indication	RIO-DW-002	NAI	
TC-H0602	Temperature Setpoint	RIO-DW-002	AO	
YI-H0603	Normal Mode	RIO-DW-002	NDI	
YI-H0604	Summer Mode	RIO-DW-002	NDI	
YI-H0605	Winter Mode	RIO-DW-002	NDI	
TI-H0601	Outside Ambient Air Temp	RIO-DW-002	AI	
TI-H0621	Press Room Temp	RIO-DW-002	AI	
TAL-H0621	Press Room Low Temp	RIO-DW-002	NDI	
TAH-H0621	Press Room High Temp	RIO-DW-002	NDI	
AI-H0622	Humidity	RIO-DW-002	AI	
AAL-H0622	Low Humidity	RIO-DW-002	NDI	
AAH-H0622	High Humidity	RIO-DW-002	NDI	
TI-H0652	Supply Air Temp	RIO-DW-002	AI	
TAL-H0652	Supply Air Low Temp	RIO-DW-002	NDI	
TAH-H0652	Supply Air High Temp	RIO-DW-002	NDI	
AAH-H0614	Smoke Detection	RIO-DW-002	DI	
FAL-H0654	Supply Air Low Flow	RIO-DW-002	DI	
TI-H0656	Exhaust Air Temp	RIO-DW-002	AI	
TI-H0660	Exhaust Fan Air Temp	RIO-DW-002	AI	
FAL-H0665	Exhaust Air Low Flow	RIO-DW-002	DI	
ZI-H0666	Damper Position Indication	RIO-DW-002	AI	
ZC-H0666	Damper Position Control	RIO-DW-002	AO	
YA-H0814	Fire Alarm Control Panel Supervisory	PLC-DW-001	DI	
YA-H0815	Fire Alarm Control Panel Trouble	PLC-DW-001	DI	
YA-H0816	Fire Alarm Control Panel Alarm	PLC-DW-001	DI	
TI-H0601	Outside Ambient Temp Retransmitted	RIO-DW-002	AO	
TI-H0621	Press Room Temp Retransmitted	RIO-DW-002	AO	
TC-H0602	Temperature Setpoint Retransmitted	RIO-DW-002	AO	

Tag Number	Service Description	PLC/RIO	Type	Remarks
YC-H0621	Enable Gas Burner	RIO-DW-002	DO	
YI-H0621	Supply Fans Running Status	RIO-DW-002	DO	
YA-H0621	Gas Burner Alarm	RIO-DW-002	DI	
TI-H0601	Outside Ambient Temp Retrasmitted	RIO-DW-002	AO	
TI-H0621	Press Room Temp Retrasmitted	RIO-DW-002	AO	
TC-H0602	Temperature Setpoint Retrasmitted	RIO-DW-002	AO	
AI-H0622	Press Room Humidity Retrasmitted	RIO-DW-002	AO	
YC-H0622	Enable Evaporative Cooler	RIO-DW-002	DO	
YI-H0622	Supply Fans Running Status	RIO-DW-002	DO	
YA-H0622	Evaporative Cooler Alarm	RIO-DW-002	DO	

1. NOTES: Input/Output types are as follows:
  - a. DI – Discrete Input
  - b. DO – Discrete Output
  - c. AI – Analog Input
  - d. AO – Analog Output
  - e. NDI – Networked Discrete Input
  - f. NDO – Networked Discrete Output
  - g. NAI – Networked Analog Input
  - h. NAO – Networked Analog Output

**PART 3 – EXECUTION (NOT USED)**

**END OF SECTION**

**SECTION 40 61 96**  
**PROCESS CONTROL DESCRIPTIONS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.
- B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.
- C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.
- D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through individual equipment suppliers.
- E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the electrical subcontractor under Division 26. The electrical subcontractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 01 14 00 – Coordination with Owner's Operations
- B. Section 40 61 91 – Process Control System Instrument List
- C. Section 40 61 93 – Process Control System Input/Output List

## **PART 2 – FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL**

### **2.01 DEFINITIONS**

- A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).
- B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).
- C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.
- D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

### **2.02 CONVENTIONS**

- A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:
  - 1. Running/On/Open: Green
  - 2. Auto/Ready: White
  - 3. Stopped/Off/Closed: Red
  - 4. Fail/Alarm: Amber
  - 5. Generic Status: White

### **2.03 PROCESS CONTROL**

- A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.
- B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:
  - 1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.
  3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).
  4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.
- C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the operator workstations.
- D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.
- E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.
- F. A control discrepancy alarm shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.
- G. An instrument failure alarm shall be generated for any instrument which is generating a signal that is less than 4 mA or greater than 20 mA.
- H. Unless otherwise specified in an individual control description, an instrument failure or control discrepancy alarm shall cause the control strategy to maintain last values and to generate an alarm. Manual initiation of the automatic control strategy shall be required.
- I. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.
- J. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

## **2.04 PROCESS CONTROL DESCRIPTIONS**

1. Refer to specification 23 09 00 HVAC Automatic Temperature Controls for complete sequence of operation.

**PART 3 –**

**END OF SECTION**

**SECTION 40 62 63**  
**OPERATOR INTERFACE TERMINALS (OIT)**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all operator interface terminals, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 63 43 – Programmable Logic Controllers

**PART 2 – PRODUCTS**

**2.01 OPERATOR INTERFACE TERMINAL – LARGE**

- A. An Operator Interface Terminal (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIT shall provide the following features as a minimum:
  - 1. Minimum of 10.4 inch diagonal display
  - 2. 18-bit color TFT LCD 800 x 600 SVGA display
  - 3. Backlit analog resistive touch screen interface w/ 1 million press actuation rating
  - 4. Backlight w/ min. 50,000 hour life to half brightness
  - 5. Minimum of 512 MB internal storage
  - 6. Minimum of 512 MB RAM application memory
  - 7. Minimum of 80 MB nonvolatile user memory
  - 8. Windows CE Operating System
  - 9. Battery-backed real-time clock
  - 10. Secure Digital (SD) card slot w/ min. 2 GB card



11. One USB 2.0 high-speed Type A host port; one USB 1.0 high-speed Type B device port
  12. One 10/100Base-T Auto MDI/MDI-X Ethernet port
  13. Windows-based configuration software complete with download cable
  14. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
  15. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
  16. Environment: 0-55°C, 5-95% relative humidity, non-condensing
- B. The operator interface terminal shall be Allen-Bradley PanelView Plus 7 Standard 1000, or equal.

## **PART 3 – EXECUTION**

### **3.01 REQUIREMENTS**

- A. The OIT shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall be displayed with associated engineering units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.
- B. Programming software shall be FactoryTalk ME.
- C. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.
- D. Unless otherwise indicated, each OIT shall be mounted between 48 and 60 inches above the floor or work platform.
- E. Refer to Section 40 61 13 – Process Control System General Provisions, for additional requirements.

**END OF SECTION**

**SECTION 40 63 43**  
**PROGRAMMABLE LOGIC CONTROLLERS (PLC)**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers (PLC), with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 23 – Signal Coordination Requirements
- C. Section 40 62 63 – Operator Interface Units
- D. Section 40 66 00 – Network and Communication Equipment
- E. Section 40 67 63 – Uninterruptible Power Systems
- F. Section 40 67 00 – Control System Equipment Panels and Racks

**1.03 TOOLS, SUPPLIES AND SPARE PARTS**

- A. Tools, supplies and spare parts shall be provided as specified.. In addition, the following specific spare parts items shall be provided:
  - 1. One of each type and size of module for PLC equipment furnished under this Contract.
  - 2. One of each type and size of PLC and equipment power supply furnished under this Contract.

**PART 2 – PRODUCTS****2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL**

- A. The instrumentation subcontractor shall furnish programmable controllers (PLCs) as specified herein and as shown on the Drawings. PLCs shall be provided complete with backplane, power supply, I/O cards, special function cards, instructions, memory,

input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.

- B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
- C. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°C-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.
- D. Where applicable, the minimum PLC backplane size shall be 7 slots, not including power supply slots.
- E. System configuration shall be as shown on the Control System Architecture Drawing. PLC types shall be designated on the Control System Architecture Drawing and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory and processor shall be adequate for all control functions specified. PLCs shall be as manufactured or equal to the following:

## **2.02 COMMUNICATIONS**

- A. PLC communications shall be provided as specified in Section 40 66 00 – Network and Communication Equipment and as shown on the Control System Architecture Drawing.
- B. In addition to a communications port for the control system network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.
- C. The PLC shall be able to support various types of fieldbus communication systems for data links to field instruments (where specified) in addition to connected equipment such as power monitors, VFDs, motor protection monitors, etc. As a minimum, Profibus DP, Foundation Fieldbus, Modbus RTU Master and Slave, TCP/IP Ethernet shall be supported. The Contractor shall coordinate the efforts of the necessary parties (instrumentation subcontractor and equipment suppliers) to accomplish the required device and data table addressing between each PLC and the associated connected equipment.

- D. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract and shall be supplied at no extra cost to the Owner.

### **2.03 INPUT/OUTPUT SUBSYSTEMS**

- A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.
- B. Discrete inputs shall be 24 VDC or 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC or 120 VAC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 40 61 23 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 40 78 00 – Panel Mounted Instruments. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.
- C. Analog input circuits shall be isolated, minimum 16-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTDs. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 420 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 40 78 56 – Isolators, Intrinsically-Safe Barriers, and Surge Suppressors. Maximum density for analog I/O modules shall be 8 per module.
- D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting

mode or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

- E. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

## **2.04 REMOTE I/O SUBSYSTEMS**

- A. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be Allen-Bradley Controllogix 1756-RIO modules. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.
- B. Remote I/O shall communicate with the PLC using the PLC manufacturer's standard protocol or an open standard network such as DeviceNet, Ethernet IP, ProfiNet, Foundation Fieldbus, Modbus TCP/IP, or equal.

## **2.05 INPUT/OUTPUT CIRCUIT ARRANGEMENT**

- A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

# **PART 3 – EXECUTION**

## **3.01 REQUIREMENTS**

- A. PLC programming shall be furnished to perform all functions described on drawings and in the sequence of operation in specification 23 09 00 – HVAC Automatic Temperature Controls, including global functions. In addition, PLCs shall be programmed to provide additional functions described in other Sections of this Division.
- B. PLC programming shall make use of the various IEC languages as appropriate to the specific task and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease of modification of the program code through the elimination of multiple instances of repeated code for the same function in a “hard-coded” style.

- C. Extensive comments shall be placed in the program code to describe the functions of all elements of the program code. PLC code that does not contain comments shall be rejected.
- D. Refer to 23 09 00 – HVAC Automatic Temperature Controls , Part 3 for additional requirements.

### **3.02 REQUIREMENTS FOR MANUFACTURER-SUPPLIED PLCS**

- A. PLCs that are supplied for equipment local control panels by individual equipment manufacturers or suppliers shall, where so indicated on the Control System Architecture Drawing, be integrated into the plant control system. The manufacturer-supplied PLC shall be furnished, installed and programmed by the manufacturer. The PLC shall continuously monitor and control the associated system and at the same time shall provide all the required alarms, indications of system parameters, equipment status, etc. to the main control system at the plant.
- B. Where required as described above, each manufacturer-supplied PLC shall be connected to the Ethernet process control network for access from the plant control system HMI servers, as specified in Section 40 66 00 – Network and Communication Equipment, and shall contain a fiber optic Ethernet switch identical to those provided for the rest of the network-connected PLCs.
- C. Each equipment manufacturer shall provide all monitoring and control data to be transferred between the PLC and the plant control system in contiguous blocks of PLC registers to facilitate block read and write commands for efficient scanning by the control system SCADA servers. These contiguous registers shall be arranged in a single data transfer area, which shall be divided into eight distinct areas with an emphasis on flexibility and future expansion. The distinct areas shall be arranged by data type (analog or discrete), transfer direction (server to PLC or PLC to server), and, where applicable, implementation schedule (current or future). Where required, peer-to-peer communication between PLCs shall likewise be accomplished using separate blocks of contiguous registers. Where individual equipment PLCs are not required to be connected to the plant control system via the data highway network, they shall provide the individual hardwired signals as specified in the Contract Documents. Data and commands for connection to the control system are described in the Drawings, the Input/Output Schedule, and the individual equipment Specification Sections
- D. The operator interface for control of each individual system shall be performed by local operator interface units as specified in Section 40 62 63 – Operator Interface Terminals or individual pilot devices on the equipment local control panel, as specified in the associated equipment Specification Section. Additional operator interface functions shall be provided through the plant control system as specified in the respective equipment specifications.

- E. Where operator interface and control functions are required to be provided through the plant control system, the individual system supplier shall be responsible for coordination with the instrumentation subcontractor to provide a complete and working equipment control system. The individual equipment supplier shall also be responsible for limiting the access of the plant control system to the equipment PLC code so as to prevent malfunctions of the equipment and any failure to continuously perform its intended functions. The equipment supplier shall be responsible for ensuring that no actions by the plant control system can damage or otherwise adversely affect the operation of the associated equipment or the safety of personnel working on or near that equipment. The equipment supplier shall also provide direction in the configuration of the SCADA software's security system by the instrumentation subcontractor to limit access to the control functions of the equipment control system to authorized personnel only. The equipment supplier shall coordinate testing of the completed system with the instrumentation subcontractor, which shall conform to the requirements of Section 40 61 21.72 – Field Testing.
- F. The Contractor, equipment supplier and instrumentation subcontractor shall coordinate testing and startup of the equipment provided by the equipment supplier with the plant control system, including but not limited to the following tasks:
1. Provide assistance with control system testing of inputs, outputs, and control strategies as needed.
  2. Provide support or interface work necessary to perform physical checkout and field testing to the final field devices. The schedule may require the instrumentation subcontractor and equipment manufacturer personnel to perform loop checks simultaneously, as directed by the Engineer.
  3. Coordinate and assist as needed to maintain I/O connectivity throughout the system.
  4. Ensure personnel safety while equipment is exercised via the plant control system.
  5. Ensure that process, instrumentation, and control equipment are not damaged while equipment is exercised via the plant control system.
  6. Provide temporary modifications to field devices and their terminations, if needed.
  7. Providing labor and supervision, which may include, but is not limited to, the following: electricians, instrument technicians, manufacturer's representatives, and individual(s) knowledgeable about process startup and operation.
  8. Operation of process equipment for verification of each plant control system input and output.

**END OF SECTION**



**SECTION 40 66 00**  
**NETWORK AND COMMUNICATION EQUIPMENT**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 ethernet local area network(s) for communications among plant devices.
- B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 63 43 – Programmable Logic Controllers

**1.03 TOOLS, SUPPLIES AND SPARE PARTS**

- A. The following specific spare parts items shall be provided:
  - 1. A termination tool kit shall be provided containing all required tools and consumables for up to 25 connections of each connection type furnished. Termination kit shall be as manufactured by Black Box, Corning Cable Systems, Optical Cable Corporation, or equal.
  - 2. One (1) spare switch of each type furnished under this Contract.
  - 3. Two (2) spare patch cables of each type and of the maximum length used.
  - 4. Two (2) spare GBIC or SFP modules for each type used.
  - 5. One (1) spare media converter for each type used.

**1.04 SUBMITTALS**

- 1. Fiber optic testing results, including signal attenuation for each fiber

**PART 2 – PRODUCTS****2.01 LOCAL AREA NETWORK (LAN)**

04/29/2022

- A. An IEEE 802.3 ethernet local area network shall be used for communications between plant devices.
- B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.
- C. The Contractor may provide a network configuration different from that shown in the Contract Drawings with written approval of the Engineer, but the Contractor shall coordinate with all affected trades and pay for all additional charges incurred.
- D. The Contractor shall provide appurtenances, including but not limited to, all hardware, cables, connectors, adapters, modules, and software, to implement a network as required for a fully functional system even if not explicitly specified or shown.

## **2.02 INDUSTRIAL ETHERNET NETWORK SWITCHES**

- A. Except where specifically allowed on the Control System Architecture Drawing, industrial ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.
- B. Ethernet network switches shall support ring, bus, star, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending faults. Ethernet network switches shall be replaceable on-line without disrupting the network. The ethernet network switches shall be integrated into the in-plant Ethernet network to form a redundant ring network with self-healing communication recovery. Switches shall support the non-proprietary Media Redundancy Protocol (MRP) and Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, all of which shall provide self-healing communication recovery.
- C. Ethernet network switches shall meet the following minimum performance requirements:
  - 1. Functions: Modular managed switch with store and forward switching mode, 10 Mbps ethernet, or 100 Mbps Fast-Ethernet, or gigabit Ethernet support, multi-address capability, auto-crossing, auto-negotiation, auto-polarity. Port speed and duplex auto-negotiation shall be configurable.
  - 2. Management: Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.

3. Power Requirements: Redundant 24 VDC power supply
  4. Operating Temperature: 0 to 60 degrees C
  5. Relative Humidity: 10 to 95%
  6. Network Size: Up to 50 nodes in ring structure; otherwise unlimited
  7. Port Type & Quantity (at each PLC location): minimum of four (4) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment and two (2) 100/1000Base-FX, multimode fiber optic cables (62.5/125  $\mu\text{m}$ ), LC, ST or SC sockets, 0-5000 meters LAN segment
  8. Link Budget: 8 dB @ 1300 nm; 10 dB @ 850 nm
  9. Wavelength: 850 or 1300 nm
- D. Acceptable industrial ethernet network switches shall be as manufactured by Cisco Systems, Hirschmann, Phoenix Contact, Weidmuller, or equal.

### **2.03 OFFICE-GRADE ETHERNET NETWORK SWITCHES**

- A. Where specifically called out on the Drawings or where located in a suitable office-type environment (e.g., administration areas), office-grade Ethernet switches shall be provided for connectivity to the process control system network.
- B. Office-grade ethernet switches shall be 19" rack-mounted as shown on the Drawings and shall meet the following specifications:
1. Functions/Protocol: Same as industrial switches
  2. Power Requirements: Redundant 120 VAC power supply
  3. Operating Temperature: 0 to 40 degrees C
  4. Relative Humidity: 10 to 95%
  5. Port Type & Quantity: Minimum of twelve (12) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment; two (2) 100/1000Base-FX, multimode fiber optic uplinks (62.5/125  $\mu\text{m}$ ), LC, ST or SC sockets, 0-500 meters LAN segment
- C. Office-grade ethernet switches shall be Catalyst series by Cisco Systems, or equal.

### **2.04 UNSHIELDED TWISTED PAIR CABLE**

- A. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 (i.e., Cat6) specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek, Belden equivalent, or equal. Connectors shall be modular RJ-45 plug.
- B. Solid conductors shall be used for all field wiring and punch-down applications. For patch cable applications and where installed-flexibility is necessary, such as for movable equipment or across enclosure door hinges, conductors shall be stranded.
- C. For use as ethernet, Contractor's conduit/cable routing shall be limited to the maximum ethernet length of 100m. If this cannot be accomplished, Contractor shall design and provide a system utilizing long-range copper extenders or fiber with media conversion or similar to overcome distance limitations, subject to Engineer's approval.
- D. Provide copper patch panels where more than one copper communication cable leaves the enclosure.

## **PART 3 – EXECUTION**

### **3.01 GENERAL REQUIREMENTS**

- A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.
- B. Refer to Section 40 61 13 – Process Control System General Provisions for additional requirements.

**END OF SECTION**

**SECTION 40 67 00**  
**CONTROL SYSTEM EQUIPMENT PANELS AND RACKS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place, in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.
- B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.
- C. Either manufacturer's standard or custom enclosures may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.
- D. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).
- E. The terms enclosure, cabinet, and panel shall be considered the same product and are used interchangeably.

**1.02 SUBMITTALS**

- A. Submittals shall be per Section 40 61 15 – Process Control System Submittals.
- B. Thermal calculations.
- C. Proof of circuit breaker selective coordination.

**1.03 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 78 00 – Panel Mounted Instruments

- C. Section 40 70 00 – Instrumentation for Process Systems
- D. Refer to Division 26 for additional requirements for conductors, circuit breakers, disconnect switches, etc.

#### **1.04 PANEL LOCATION AND TYPE**

- A. For locations inside buildings in areas other than climate controlled (i.e., heated and air conditioned) electrical or control rooms, panel shall be Type 316 stainless steel NEMA 4X construction, or as indicated for hazardous area classification (Class, Division, at a minimum), or submersible, NEMA 6, applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications.
- B. For locations in storage/feed areas for chlorine or other applicable corrosive chemicals, panel shall be of non-metallic construction, rated NEMA 4X, and be fully compatible with the associated chemical.
- C. For locations within climate controlled (i.e., heated and air-conditioned) electrical or control rooms, panel shall be a painted steel fully enclosed NEMA 12 units with gasketed doors.
- D. For outdoor locations, panel shall be Type 316L stainless steel NEMA 4X construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.

### **PART 2 – PRODUCTS**

#### **2.01 CABINETS AND PANELS**

- A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
- B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
- C. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.

- D. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits. Coordinate keying with Owner.
- E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- F. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.
- G. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.
- H. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

## **2.02 FIELD PANELS**

- A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:
  - 1. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.
  - 2. Field panels located outside fence-secured areas shall be fitted with staple and hasp. Provide padlock and coordinate keying with Owner.
  - 3. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.
  - 4. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sun shield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.
- B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to

the temperature of the lines. Heat tape shall be powered from an equipment-safety GFCI circuit from within panel, unless otherwise shown or specified.

- C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.
- D. Field panels shall be as manufactured by Hoffman, Saginaw Control & Engineering (SCE), or equal.

### **2.03 CABINET AIR CONDITIONING UNITS**

- A. Where indicated or required due to ambient conditions and panel component ratings, panel-mounted closed loop air conditioning units and thermostatically controlled space heaters shall be provided.
- B. Air conditioning units shall both cool and dehumidify the cabinet's internal air. Each air conditioner shall be sized to handle current and future (with specified spare capacity filled) heat loadings from all equipment mounted inside the cabinet.
- C. Air conditioners shall be provided with thermostats which operate the centrifugal evaporator blowers continuously to prevent stratification of air within the cabinet. Compressors shall operate as needed to maintain the temperature set at the thermostat. Compressors shall be provided with space heaters to maintain the compressor at a minimum temperature during cold ambient temperatures.
- D. Ambient air shall be completely separated from the air inside the cabinet. All air conditioner components exposed to the atmosphere outside the cabinets shall be coated to prevent corrosion.
- E. Power supply shall be 115VAC, 60 Hz. Units shall be provided with EMI/RFI noise suppressors.
- F. Air conditioner enclosures shall be constructed of stainless steel or cold rolled steel which is phosphatized and finished in baked enamel.
- G. Cabinet air conditioners shall be ProAir CR Series as manufactured by McLean Midwest of Brooklyn Park, MN, or equal.

### **2.04 TERMINAL BLOCKS**

- A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.



- B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.
- C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

## **2.05 NAMEPLATES**

- A. Items of equipment installed in control panels shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.
- D. Submit sample nameplate of each type.

## **PART 3 – EXECUTION**

### **3.01 FABRICATION**

- A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.
- B. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

- C. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:
1. For NEMA 12 cabinets only, louvered openings near the bottom and top or thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet. Air velocities through the enclosure shall be minimized to assure quiet operation.
  2. Thermostatically controlled, low noise internal air blowers to circulate air within the enclosure, maintaining a uniform internal temperature. Initial setpoint shall be 75 degrees F.
  3. All intake openings in cabinets and panels shall be fitted with dust filters.
- D. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.
- E. The temperature inside each enclosure containing digital hardware (e.g., PLC, computer, Ethernet switch) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure "high interior temperature" alarm shall be displayed on the HMI or OIT.
- F. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened. If panel contains a service light, alarm switch shall also be wired to turn light on when door is opened.
- G. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.
- H. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

- I. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.
- J. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring when operating at differing voltages.
- K. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.
- L. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.
- M. A copper ground bus shall be installed in each cabinet and shall be connected to the building power ground.
- N. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 26 05 19 – Low-Voltage Conductors and Cables. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 26 05 19 – Low-Voltage Conductors and Cables. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
- O. Wires shall be color coded as follows:
  1. Equipment Ground – GREEN
  2. 120 VAC Power – BLACK
  3. 120 VAC Power Neutral – WHITE
  4. 120 VAC Control (Internally Powered) – RED
  5. 120 VAC Control (Externally Powered) – YELLOW
  6. 24 VAC Control – ORANGE
  7. DC Power (+) – RED

8. DC Power (-) – BLACK
  9. DC Control – BLUE
  10. Analog Signal – BLACK/WHITE or BLACK/RED
- P. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a circuit will trip only its immediate breaker and not the upstream breaker.
- Q. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.
- R. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power." Letters in the word "WARNING" shall be 0.75 inch high, white.
- S. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

### **3.02 PAINTING/FINISHING**

- A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 09 for additional requirements.
- B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.
- C. Panels fabricated from stainless steel shall not be painted.
- D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be otherwise painted.

### **3.03 INSTALLATION**

- A. Refer to Section 40 61 13 – Process Control System General Provisions for additional requirements.

**END OF SECTION**

**SECTION 40 67 63**  
**UNINTERRUPTIBLE POWER SYSTEMS**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. One UPS shall be provided for each operator workstation and its peripherals (i.e. printer, network equipment, radio, etc.) provided under this Contract.
- C. One UPS shall be provided for each programmable logic controller (PLC) panel or remote telemetry unit (RTU) and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC and RTU cabinets shall not be powered by the UPS.
- D. UPS units shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:
  - 1. UPS units for operator's consoles shall be mounted within the consoles.
  - 2. UPS units for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.
  - 3. UPS units for RTUs shall be mounted within the RTU cabinet.
- E. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 40 67 00 – Control System Equipment Panels and Racks and its subordinate Sections.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 63 43 – Programmable Logic Controllers

**1.03 SUBMITTALS**

- A. Sizing calculations, in Watts (W) or Volt-Amps (VA), for all UPS units.
- B. Heat dissipation calculations for all enclosures that contain a UPS unit.

- C. Run time calculation.

## **PART 2 – EQUIPMENT**

### **2.01 UNINTERRUPTIBLE POWER SYSTEMS**

- A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.
- B. UPS units shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
- C. An automatic bypass switch shall be provided with UPS units of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
- D. A manually operated maintenance bypass switch shall be provided for each UPS installation, other than for computers, to allow the hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the load.
- E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.
- F. Each UPS shall meet the following requirements:
  - 1. Input voltage shall be 117 VAC, single phase, 60 Hz.
  - 2. Voltage regulation shall be +/-5 percent for line and load changes.
  - 3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
  - 4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

5. The UPS capacity shall be sized for 150% of the connected load.
  
6. A status monitoring and control panel shall be provided and shall include the following:
  - a. Status indicating lights for both normal and abnormal conditions.
  - b. Individual alarm contacts that shall close upon:
    - 1) Loss of the AC line
    - 2) Low battery level
    - 3) Fault condition.
  - c. All monitoring shall be conveyed over EtherNet/IP communication.
  - d. Circuit breaker for the AC input.
  
7. Sound absorbing enclosure.
  
8. EMI/RF noise filtering.
  
9. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
  
- G. UPS systems shall be the 9PX series by Eaton, Smart-UPS On-line series by APC/Schneider-Electric, or equal.

## **PART 3 – EXECUTION**

### **3.01 REQUIREMENTS**

- A. Where the UPS is mounted within the PLC or RTU cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.
  
- B. Refer to Section 40 61 13 – Process Control System General Provisions for additional requirements.



**END OF SECTION**

**SECTION 40 68 00.13**  
**PROCESS CONTROL SOFTWARE (MODIFY EXISTING)**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install, and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 93 – Control System Input/Output List
- C. Section 40 61 96 – Process Control Descriptions

**PART 2 – PRODUCTS - (NOT USED)**

**PART 3 – EXECUTION**

**3.01 OVERALL SYSTEM CONFIGURATION**

- A. The Owner’s existing Human-Machine Interface (HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.
- B. The Owner’s existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

**3.02 SOFTWARE MODIFICATIONS**

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the “look and feel,” in the opinion of the Engineer, of the existing SCADA System. Specified features and functions of this Contract that do not already exist, even if only for “look and feel,” shall be provided. Details on how to best implement these features and functions shall be discussed with Owner and Engineer.
- B. Major HMI software scope of work shall include, but shall not be limited to, the following:

1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
  2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.
  3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.
  4. Modify existing reports to include the additional monitoring points specified under this Contract.
  5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.
  6. Update the system status display to include new hardware provided under this Contract.
- C. Ladder logic resident in existing PLCs shall be modified to perform the functions described as specified herein, in Section 40 61 96 – Process Control Descriptions, and in Section 23 09 00 – HVAC Automatic Temperature Controls. Specifically, the existing PLCs shall be programmed to accept the I/O specified in Section 40 61 93 – Control System Input/Output List and to make this data readily available on the plant network and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- D. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

**END OF SECTION**

**SECTION 40 70 00**  
**INSTRUMENTATION FOR PROCESS SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The instrumentation subcontractor shall furnish, install, test and place in operation instruments as scheduled together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Contractor may elect to install sensors on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as indicated.
- B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Instrumentation Subcontractor shall supervise installation of equipment provided where installation is by other Subcontractors or Contractors.
- C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments are 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.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 91 – Process Control System Instrument List
- C. Section 40 67 00 – Control System Equipment Panels and Racks
- D. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.

## PART 2 – PRODUCTS

### 2.01 GENERAL

- A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, 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 a hazardous area shall meet or exceed Class, Group, and Division requirements as shown on the Drawings, to comply with the National Electrical Code.
- C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:
  - 1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.
  - 2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 40 67 00 – Control System Equipment Panels and Racks, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.
- D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.
- E. 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 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0 to 100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

- F. Unless otherwise specified, field instrument and power supply enclosures shall be Type 316 stainless steel, fiberglass (or similar, per Engineer's judgement) or PVC coated copper-free cast aluminum NEMA 4X construction.
- G. 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.
- H. 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 atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 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.
- I. 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 that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.
- J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC 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 regulation, constant voltage transformers shall be supplied.
- K. All analog transmitter and controller outputs shall be isolated, 4 to 20 milliamps into a load of 0 to 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.
- L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

## **2.02 ANALYTICAL INSTRUMENTATION**

- A. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.
- B. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.

- C. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.
- D. Each analyzer requiring reagents or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.
- E. Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.
- F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

#### **A. General**

- 1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of process instrumentation supplied under this Division.
- 2. Work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, the latest version of the American Petroleum Institute (API) Recommended Practice 551 manual (API RP 551) 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 pipe stands welded to a 10 inch square by 1/2 inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced

out from the mounting surface not less than 1/2 inch by use of phenolic spacers. Expansion anchors 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, Type 316 stainless steel pipe, ASA B 36.19, with stainless steel blind flange for equipment mounting, unless otherwise indicated.
3. Materials for miscellaneous mounting brackets and supports shall be Type 316 stainless steel construction.
4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 05 of the specifications.
5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. 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.

### 3.02 ADJUSTMENT AND CLEANING

- A. The instrumentation subcontractor shall comply with the requirements of Division 01 of these Specifications 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/her designated representative(s), reserves the right to witness any test, inspection, calibration or start up activity. Acceptance by the Engineer of plans, reports, or documentation relating to testing or commissioning activity shall not relieve the Contractor of his/her responsibility for meeting all specified requirements.
- B. The instrumentation subcontractor 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. Instruments which fails to meet Contract requirements, or 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 provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.



- C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description of the installation test(s) to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.
- D. Field instrument calibration shall conform to the following requirements:
1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate or verify factory calibration of each instrument supplied under this Contract and existing instruments shown to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration. Calibration and verification shall take place under actual process conditions. Forcing outputs shall not be acceptable.
  2. Each instrument shall be calibrated/verified 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 (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).
  3. The instrumentation subcontractor shall provide a written calibration/verification sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, brief description of how the calibration process was performed, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the 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. For electronic or powered instruments, the calibration/verification sheet shall also list all configurable parameters that have been modified from their default factory setting.
  4. If doubt exists as to the correct method for calibrating or checking the calibration/verification of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
  5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to adjustments, 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 from being subjected to over-voltages, incorrect voltages, overpressure or

incorrect air. Damaged equipment shall be replaced and re-calibrated/verified at no cost to the Owner. Equipment that has been adjusted, modified, or moved or there is evidence of such activity shall be re-calibrated/verified at no cost to the Owner.

6. After completion of instrumentation installation, the instrumentation subcontractor 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 71 79.16**  
**FLOW SWITCHES (THERMAL)**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation the thermal dispersion flow switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. Contractor shall be responsible for coordinating process line size to match capabilities of the selected instrument. In consultation with Engineer, small diameter line sizes shall be increased in size as required to meet velocity requirements of the instrument. At no additional cost, provide reducers and increase process line size in the same material in a straight segment of pipe for a length no less than manufacturer's recommended length of straight run.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 70 00 – Instrumentation for Process Systems

**PART 2 – PRODUCTS**

**2.01 THERMAL DISPERSION FLOW SWITCHES – INSERTION TYPE**

- A. Each flow switch shall utilize a thermal dispersion type, Type 316 stainless steel sensing element (probe), unless otherwise indicated, installed in the process piping as indicated on the Drawings. Probe style shall be as determined by the manufacturer and based on the specific application.
- B. Unless otherwise indicated or recommended by the manufacturer, the element insertion length shall be approximately one-third to one-half of the pipe diameter plus allowance for mounting accessories. All mounting accessories shall be provided.
- C. The electronics shall be mounted to the sensor, unless otherwise indicated. Power supply to the unit shall be 120 VAC, 60 Hz. Where remote mounted, manufacturer shall furnish a continuous length of cable between the sensor and the electronics.
- D. The instrument shall be housed in a NEMA 4X (IP66) enclosure..

- E. The unit shall have field configurable dual SPDT or single DPDT relay contacts rated 6 amps at 115 VAC for remote alarming.
- F. Flow repeatability shall be +/-1 percent of setpoint range.
- G. Flow response time shall be as low as 3 seconds.
- H. The thermal dispersion flow switch shall be Fluid Components Model (FCI) FLT93 series, Sierra InnovaSwitch, Magnetrol Thermatel TD2 series, or equal.

### **PART 3 – EXECUTION**

#### **3.01 REQUIREMENTS**

- A. All threaded connections between stainless steel components shall be installed with process compatible anti-seize lubricant to prevent galling.
- B. Refer to Section 40 70 00 – Instrumentation for Process Systems, for additional information

**END OF SECTION**

**SECTION 40 74 00**  
**TEMPERATURE INSTRUMENTS**

**PART 1 – GENERAL**

**1.01 SCOPE**

- A. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.
- C. When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

**1.02 DESIGN CRITERIA**

- A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.
- B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.
- C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.
- D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

**1.03 SUBMITTALS**

- A. See Section 40 61 11 – Instrumentation and Control System

1. Submittals shall be as specified in the Instrumentation and Control System section.

#### **1.04 SHIPMENT, PROTECTION, AND STORAGE**

- A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

### **PART 2 – PRODUCTS**

#### **2.01 GENERAL**

- A. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Interconnecting Cable
  1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.
- C. Programming Device
  1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- D. Configuration Software/Serial Interface
  1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

## **2.02 TEMPERATURE INSTRUMENTS**

### **A. Room Temperature and Humidity Transmitter**

1. Each transmitter shall utilize a capacitive polymer temperature sensing element to provide two proportional 4-20 mA DC signals for temperature and humidity. Each transmitter shall contain screw and terminal block connections for power and signal wiring. The unit housing shall be made of a corrosion resistant material and rated NEMA 4X. The unit shall be factory calibrated and furnished with necessary wall mounting hardware. The unit shall accept 24VDC power supply from the PLC panel.
2. Room temperature and humidity transmitters shall be Belimo 22UTH-53 or approved equal.

## **PART 3 – EXECUTION**

### **A. FIELD SERVICES**

1. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.
2. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

**END OF SECTION**

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**SECTION 40 76 21**  
**SINGLE POINT GAS MONITORING SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation the single point gas monitoring systems with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 70 00 – Analytical Instrumentation for Process Systems

**1.03 TOOLS, SUPPLIES AND SPARE PARTS**

- A. One spare sensor of each type used shall be provided.
- B. Calibration equipment as recommended by the manufacturer and a one year supply of calibration gas for each gas measured shall be provided to field calibrate the gas monitoring systems.

**PART 2 – PRODUCTS**

**2.01 GENERAL**

- A. Gas monitoring systems shall include a sensor to monitor specified gas and a microprocessor-based transmitter that is capable of accepting, converting and transmitting signals from the sensor. The complete gas monitoring system including sensor, transmitter, and accessory equipment shall be supplied by a single manufacturer. One system shall be provided per gas per location.

**2.02 SENSORS**

- A. All sensors shall sample and monitor the atmosphere without the aid of pumps or other mechanical devices. Sensors and associated enclosures shall be classified as Class 1, Division 1, Group C and D as specified by the National Electric Code. Sensors shall be mounted with non-corrosive hardware as shown in the Drawings and/or as recommended by the manufacturer.

1. Combustible Gas Sensor – The combustible gas sensor shall be the infrared (IR) type. It shall be immune to poisoning by hydrogen sulfide and silicone. The IR combustible sensor shall be capable of calibration without gas and shall be capable of performing a full calibration by zero adjustment only. The IR sensor shall allow detection of an above 100% LEL condition (over-range). The IR sensor shall not contain a flashback arrestor / frit.
  2. Hydrogen Sulfide (H<sub>2</sub>S) Sensor: The hydrogen sulfide sensor shall be the electrochemical type and shall not require the periodic addition of reagents. Sensor shall carry a two-year warranty.
  3. Electrochemical (Toxic and Oxygen) Sensor – Sensors to detect toxic gases and oxygen shall be of the electrochemical type and shall not require the periodic addition of reagents.
- B. Sensors shall be contained in sensor modules mounted externally to the main enclosure. All sensor modules shall have the capability of replacement while the unit is under power (hazardous areas) without the need for tools.
- C. Sensor modules shall contain all relevant sensor information within the module so that the module may be calibrated off site. This information shall include sensor manufacturer date, gas type, gas range, calibration data, and default relay parameters. The sensor module shall not require a battery or power source to store this data.
- D. Then sensor shall be capable of being mounted remotely from the transmitter. The allowable distance from the remote mounted sensor to the transmitter shall be a minimum of 100 feet. The enclosure for the combustible gas sensor shall be classified as Class I, Division 1, Groups A, B, C & D.

**2.03 TRANSMITTER**

- A. The transmitter shall be classified as Class I, Division 1, Groups B, C & D. The transmitter shall have a digital readout to indicate the gas type being monitored and the concentration of gas present. The display shall sequentially show the gas type and gas concentration. The transmitter shall have normal, alarm, and fault indicating lights. Alarm level set points shall be adjustable by means of a hand held infrared controller.
- B. Transmitters shall have the following specifications:

<b>Temperature Range</b>	-40°C to +60°C
<b>Drift</b>	Zero drift, <5% per year Span drift, <10% per year

<b>Accuracy</b>	±1% Full scale or 2ppm, typical ±2% Full scale or 2ppm, (O <sub>2</sub> , CO) ±3% Full scale (<50% LEL combustibles) ±5% Full scale (>50% LEL combustibles) ±10% Full scale or 2ppm (non-CO toxics)
<b>Response Times</b>	<12 sec., for 20% change (oxygen and toxics) <30 sec., for 50% change (oxygen and toxics) <8 sec., for 50% change (combustibles) <20 sec., for 90% change (combustibles)
<b>Humidity</b>	15%-95% relative humidity, non-condensing
<b>Sensor Life</b>	2 years (oxygen and toxics) 3 years (combustibles)
<b>Power</b>	90 - 130 VAC, 50-60 Hz (internal power supply)
<b>Signal Output</b>	4-20 mA 2-wire current sink 4-20 mA 3-wire current source
<b>Relay Contacts</b>	Rating, 5 amp @ 220 VAC; 5 amp @ 30 VDC

- C. Calibration shall be performed by a hand held infrared controller. It shall not be necessary to open the monitor enclosure to perform calibration or adjustment of the unit. With the exception of a monthly check and recalibrations, no periodic maintenance shall be necessary.
- D. Gas monitoring systems shall be Ultima X Series as manufactured by MSA Instruments, equivalent by Draeger or Scott, or equal.

**PART 3 – EXECUTION**

**3.01 REQUIREMENTS**

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

**END OF SECTION**

**SECTION 40 76 29**  
**AMMONIA GAS MONITORING SYSTEMS**

**PART 1 – GENERAL**

**1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation the ammonia gas monitoring systems with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 70 00 – Instrumentation for Process Systems

**1.03 TOOLS, SUPPLIES AND SPARE PARTS**

- A. One spare sensor of each type used shall be provided.
- B. Calibration equipment as recommended by the manufacturer and a one year supply of calibration gas for each gas measured shall be provided to field calibrate the gas monitoring systems.

**PART 2 – PRODUCTS**

**2.01 GENERAL**

- A. Ammonia gas monitoring systems shall consist of a sensor with associated digital sensor processor and an alarm module that may be remotely mounted up to 3,000 feet away. The complete gas monitoring system including sensor, alarm module, and accessory equipment shall be supplied by a single manufacturer.

**2.02 SENSORS**

- A. Sensors shall operate on the electrochemical gas diffusion principle. Sensor shall sample and monitor the atmosphere without the aid of pumps or other mechanical devices. Sensors and associated digital sensor processors (enclosures) shall be non-metallic NEMA 4X, and shall be RFI/EMI-immune. Linearity and repeatability shall both be  $\pm 2\%$  of full-scale. Sensors shall be operable in an ambient temperature range of -25°C to 65°C. Sensors shall be mounted with non-corrosive hardware as shown in the Drawings and/or as recommended by the manufacturer.

## 2.03 ALARM MODULE

- A. The alarm module shall be enclosed in a non-metallic NEMA 4X enclosure. The alarm module shall have the following minimum performance requirements:
1. Power: 120 VAC 60 Hz
  2. Ambient operating temperature: -25° to 65°C
  3. External keypad for test, horn silence, and alarm reset
  4. Visual alarm indication
  5. Integral alarm horn
  6. Two adjustable high/low gas concentration and one common communications/logic and power fail alarm each from SPDT relays rated 120 VAC, 5 A
- B. The ammonia gas monitoring system shall be furnished with a lead-acid gel-cel battery backup system capable of operating the instrument for a minimum of three hours.
- C. Ammonia gas monitoring systems shall be Tox-alarm Model 5300 by Scott Instruments, or equal.

## PART 3 – EXECUTION

### 3.01 REQUIREMENTS

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

**END OF SECTION**

**SECTION 40 78 00**  
**PANEL MOUNTED INSTRUMENTS**

**PART 1 – GENERAL****1.01 THE REQUIREMENT**

- A. The Contractor shall furnish, test, install and place in satisfactory operation the panel mounted instruments, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 40 61 13 – Control and Information System Scope and General Requirements
- B. Section 40 67 00 – Control System Equipment Panels and Racks

**1.03 GENERAL INFORMATION AND DESCRIPTION**

- A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

**1.04 TOOLS, SUPPLIES AND SPARE PARTS**

- 1. Tools, supplies and spare parts shall be provided as specified. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.
- 2. Five of each type of interposing control relay provided under this Contract.

**PART 2 – PRODUCTS****2.01 OPERATORS**

- A. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant. For Hazardous areas, control operators shall be rated NEMA 7.
- B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type, unless otherwise indicated.
- C. Pilot lights shall be of the proper control voltage, push-to-test LED type with lens and LED lamp colors as specified below.

1. Red: stopped, off, or closed
  2. Green: running, on, or opened
  3. Amber: fault, alarm, or warning
  4. White: generic non-alarm status
  5. Blue: control power on
- D. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
- E. Control operators for all equipment under this Contract shall be of the same type and manufacturer unless otherwise indicated. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal.

## **2.02 ELECTRONIC INDICATORS**

- A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure.
- B. Indicators shall be Red Lion Model IMP or APLCL, Precision Digital, or equal.

## **2.03 RELAYS**

- A. Interposing control relays (CR)
1. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein.

2. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating.
3. Relay coils shall be 120 VAC or 24 VDC as required to interface with equipment.
4. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil.
5. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

B. Timing Relays (TR)

1. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays.
2. Timing relays shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, equivalent by Eaton/Cutler-Hammer, equivalent by Allen-Bradley, or equal.

## 2.04 TOTALIZERS

- A. Totalizing counters shall be provided for flush panel, spring-clip mounting. Face dimensions of the totalizing counters shall be no larger than 1-1/8-inches high by 2-inches wide. Totalizing counters shall contain eight digits. Height of the digits shall not be less than 5/32-inch. Numerals shall be white on a black background. The counter shall be non-resettable and shall be totally compatible for operation on the pulses supplied by the associated instrument or integrator. The totalizing counter shall be capable of a maximum count rate of 25 counts/second.
- B. Legend plates shall be provided for each of the totalizing counters with white letters on a black background with legends as specified below.
- C. Totalizing counters shall be manufactured by Kessler-Ellis, or equal.

## 2.05 ALARM HORNS

- A. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24 VDC. Horns shall be capable of producing 100 dB at 10 feet and shall have adjustable volume.



- B. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

### **PART 3 – EXECUTION**

#### **3.01 REQUIREMENTS**

- A. Refer to Section 40 67 00 – Control System Equipment Panels and Racks, for additional requirements.

**END OF SECTION**



# CENTRAL WEBER SEWER IMPROVEMENT DISTRICT OGDEN, UTAH



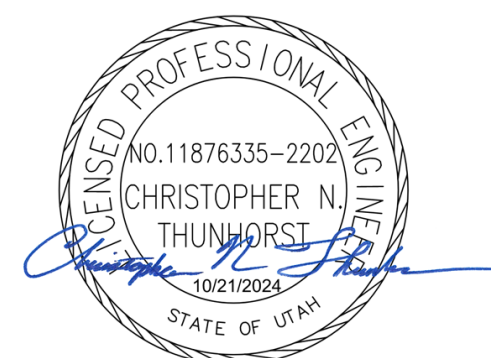
## DEWATERING BUILDING HVAC IMPROVEMENTS

VOLUME 2 OF 2: DRAWINGS

HAZEN CONTRACT NO. 70123-000  
OCTOBER 2024



**LOCATION PLAN**  
NOT TO SCALE



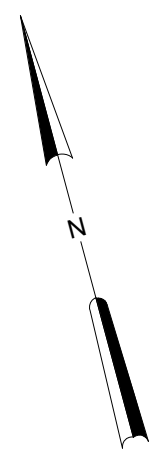
# Hazen

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY, SUITE 130  
SOUTH JORDAN, UTAH 84095

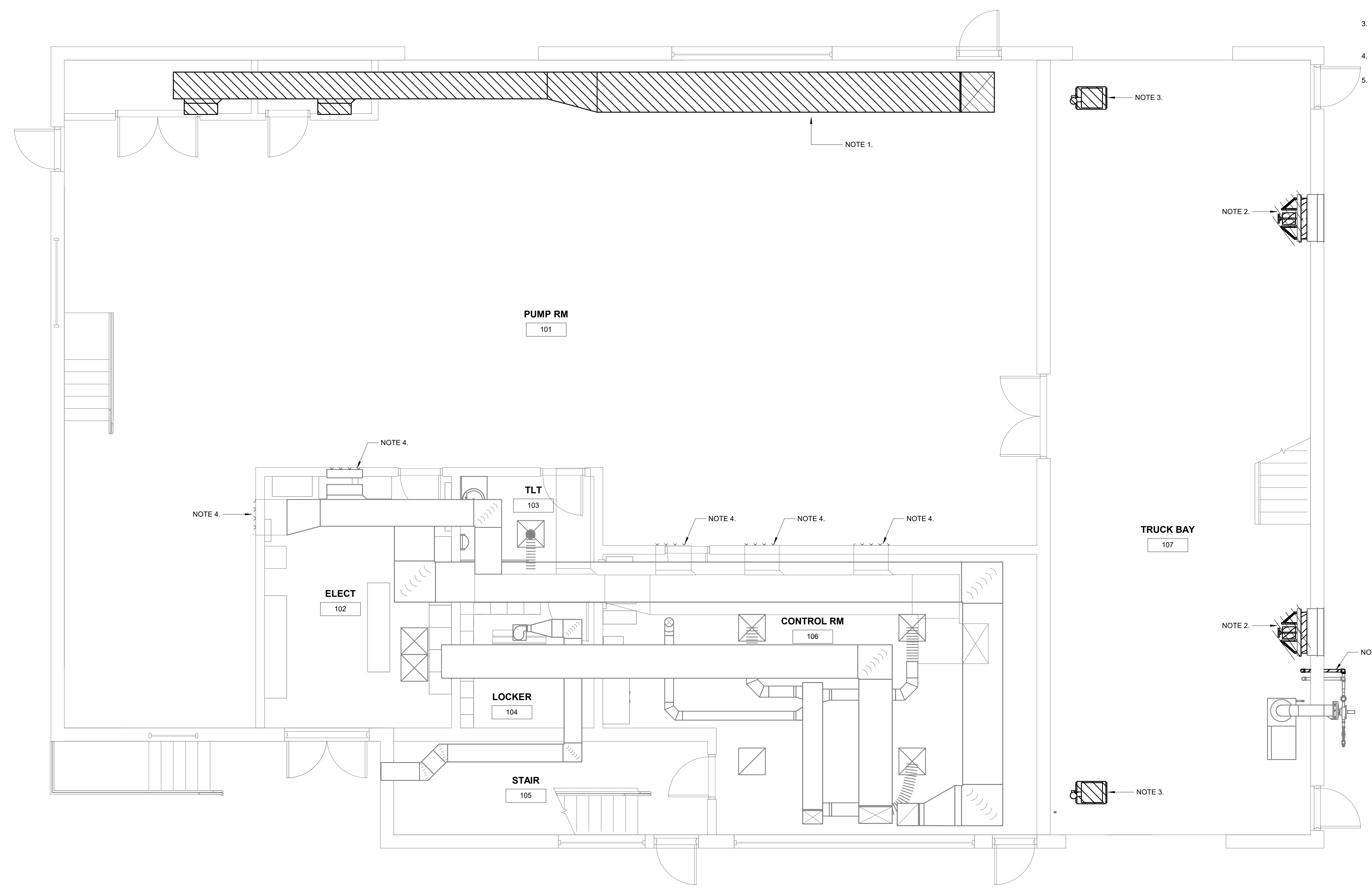
### SHEET INDEX

SHEET NUMBER	TITLE
G001	COVER SHEET
DEMOLITION	
HX001	HVAC DEMOLITION - FIRST FLOOR
HX002	HVAC DEMOLITION - SECOND FLOOR
SX001	STRUCTURAL DEMOLITION - FIRST FLOOR
SX002	STRUCTURAL DEMOLITION - MEZZANINE
SX003	STRUCTURAL DEMOLITION - ROOF
EX001	ELECTRICAL DEMOLITION - FIRST FLOOR
HVAC	
H001	GENERAL NOTES, LEGEND, AND ABBREVIATIONS
H002	SCHEDULES
H003	SCHEDULES
H004	AIRFLOW DIAGRAM
H005	FIRST FLOOR PLAN
H006	SECOND FLOOR LOWER PLAN
H007	SECOND FLOOR UPPER PLAN/THIRD FLOOR PLAN
H008	ROOF PLAN
H009	SECTIONS
H010	SECTIONS
H011	DETAILS 1
H012	DETAILS 2
H013	DETAILS 3
STRUCTURAL	
S001	GENERAL STRUCTURAL NOTES
S002	FIRST FLOOR PLAN
S003	SECOND FLOOR LOWER PLAN
S004	MEZZANINE PLAN
S005	ROOF FRAMING PLAN
S006	DOOR AND PAINTING DETAILS
S007	SECTION AND DETAILS
ELECTRICAL	
E001	LEGENDS AND SYMBOLS
E002	GENERAL NOTES AND ABBREVIATIONS
E003	FIRST FLOOR POWER AND CONTROLS PLAN
E004	FIRST FLOOR LIGHTING PLAN
E005	SECOND FLOOR LOWER POWER AND CONTROLS PLAN
E006	SECOND FLOOR LOWER LIGHTING PLAN
E007	SECOND FLOOR UPPER/ THIRD FLOOR POWER AND CONTROLS PLAN
E008	SECOND FLOOR UPPER/ THIRD FLOOR LIGHTING PLAN
E009	ROOF PLAN
E010	MCC-S1 SINGLE LINE DIAGRAM - DEMOLITION
E011	MCC-S1 SINGLE LINE DIAGRAM - MODIFIED
E012	MCC-S1 ELEVATION
E013	MCC-S4 SINGLE LINE DIAGRAM
E014	MCC-S4 ELEVATIONS
E015	PANEL SCHEDULE
E016	CONTROLS ONE LINE DIAGRAM
E017	ELEMENTARY CONTROL SCHEMATICS
E018	CONDUIT SCHEDULES
E019	STANDARD ELECTRICAL DETAILS - 1
E020	STANDARD ELECTRICAL DETAILS - 2
INSTRUMENTATION	
I001	LEGENDS AND SYMBOLS
I002	NETWORK DIAGRAM
I003	HVAC/ GAS MONITORING SYSTEM
I004	SUPPLY AND EXHAUST FANS P&ID
I005	MAU P&ID
I006	GAS BURNER AND EVAPORATIVE COOLER P&ID
I007	STANDARD DETAILS





- NOTES:
1. DEMOLISH EXISTING EXHAUST DUCT AND HANGERS AND ASSOCIATED GRILLES.
  2. DEMOLISH EXISTING EXHAUST FAN. MAINTAIN PLENUM FOR INSTALLATION OF NEW EXHAUST FAN.
  3. DEMOLISH EXISTING GAS UNIT HEATER, GAS BRANCH LINE AND ASSOCIATED FLUE PIPING.
  4. DEMOLISH EXISTING SUPPLY GRILLES AND BALANCING DAMPERS.
  5. DEMOLISH EXISTING NATURAL GAS LINE TO MAKE-UP AIR UNIT.



**DEMOLITION - FIRST FLOOR**

1/4" = 1'-0"

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE

BID SET

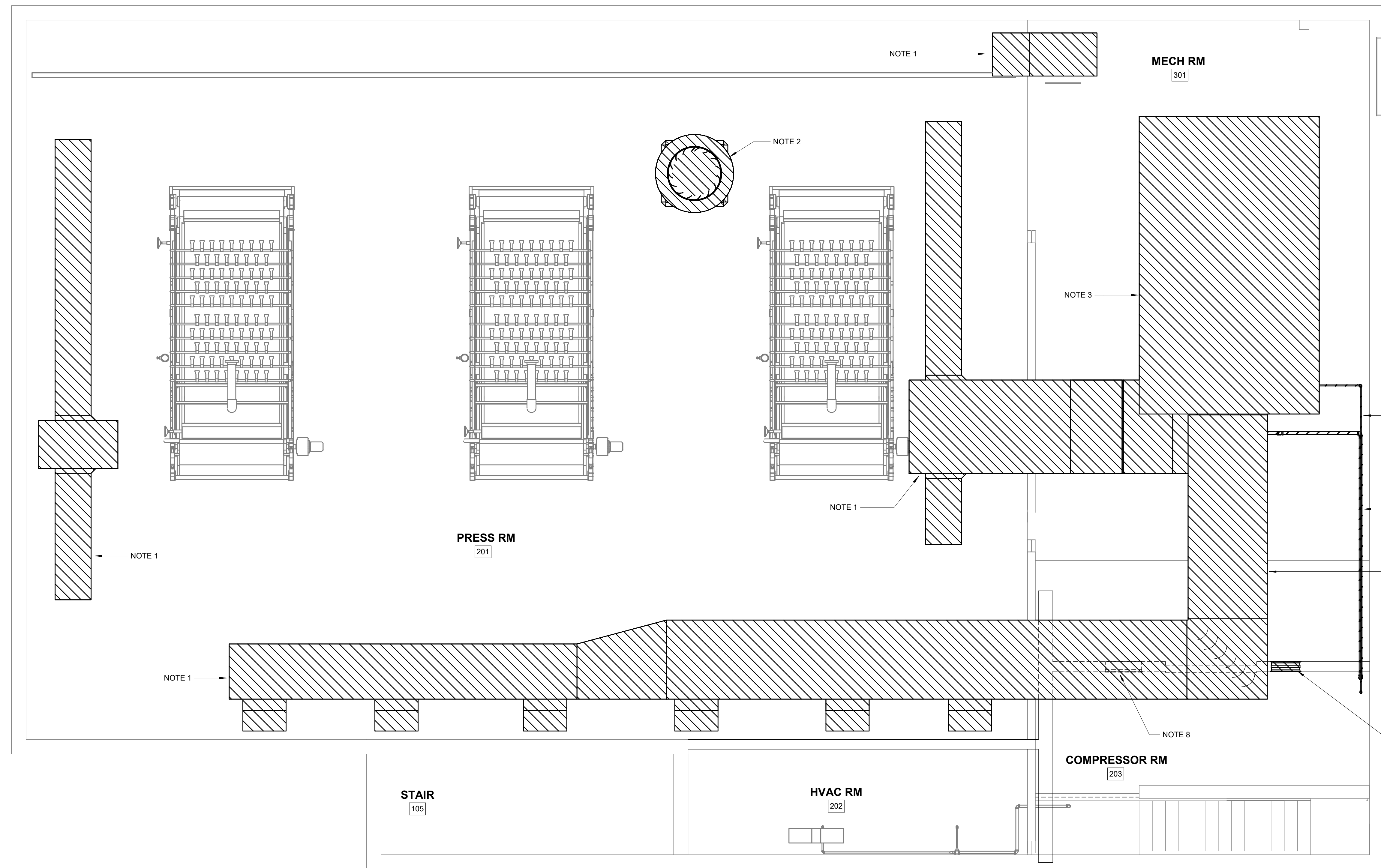
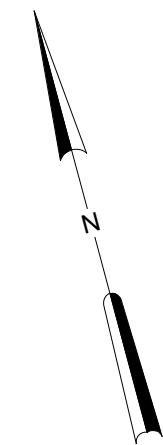


**Hazen**  
HAZEN AND SAWYER  
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CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

HVAC  
DEMOLITION - FIRST FLOOR PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	HX001



- NOTES:
1. DEMOLISH EXISTING DUCTWORK AND HANGERS AND ASSOCIATED GRILLES.
  2. DEMOLISH EXISTING EXHAUST FAN, DUCTWORK, AND ROOF CURB. REFER TO SX001 FOR ADDITIONAL REQUIREMENTS.
  3. DEMOLISH MAU IN MECH RM ABOVE..
  4. DEMOLISH DUCTS IN MECH RM ABOVE.
  5. DEMOLISH EXISTING NATURAL GAS PIPING.
  6. DEMOLISH POTABLE WATER PIPING.
  7. DEMOLISH TRANSFER GRILLES (BELOW) AND FILL IN MASONRY. FINISH SMOOTH TO MATCH ADJACENT SURFACES. REFER TO STRUCTURAL SHEET FOR DETAILS.
  8. DEMOLISH SUPPLY GRILLE IN WALL (BELOW), BELOW DUCTWORK, AND FILL IN MASONRY. FINISH SMOOTH TO MATCH ADJACENT SURFACES. REFER TO STRUCTURAL SHEET FOR DETAILS.

DEMOLITION - EL 4257.00  
1/4" = 1'-0"

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE

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**Hazen**  
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IMPROVEMENTS

HVAC  
DEMOLITION - SECOND FLOOR PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	HX002



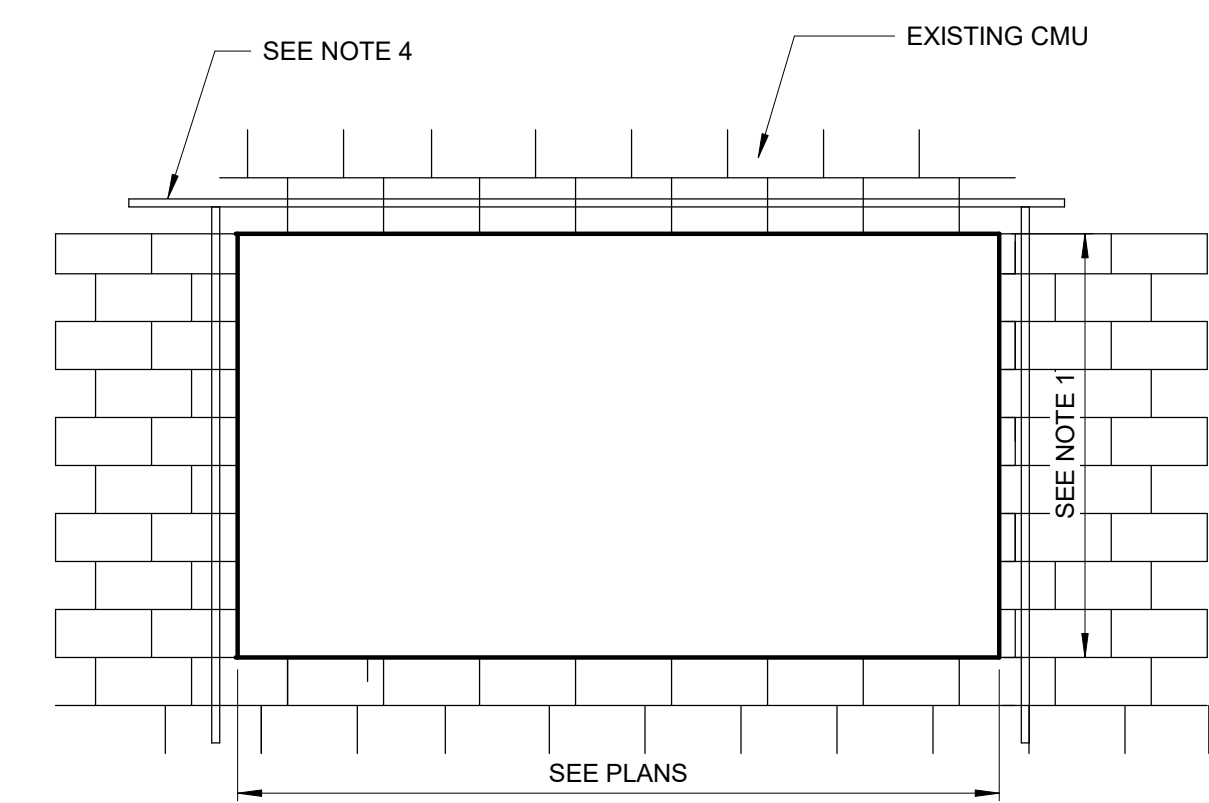
- NOTES:
- DEMOLISH EXISTING CMU BLOCK TO ACCOMMODATE NEW HVAC EQUIPMENT. NO OVER CUTTING BEYOND WHAT IS REQUIRED TO INSTALL THE REINFORCEMENT SHOWN ON THE NEW WORK DETAILS.
  - PATCH EXISTING MASONRY WALL AS REQUIRED TO MATCH EXISTING. ANY DAMAGE TO EXISTING MASONRY WALL NOT INCLUDED IN THE EXTENTS OF DEMOLITION SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REPAIR AND/OR RESTORE.
  - LOCATION OF NEW OPENINGS IN CMU WALLS SHALL BE FIELD VERIFIED. ENSURE NEW OPENINGS DO NOT INTERFERE WITH EXISTING STRUCTURAL MEMBERS OR MECHANICAL EQUIPMENT. SHOULD INTERFERENCES BE IDENTIFIED, CONTRACTOR SHALL NOTIFY ENGINEER PRIOR TO DEMOLITION.



PHOTO 11  
NO SCALE  
SX001

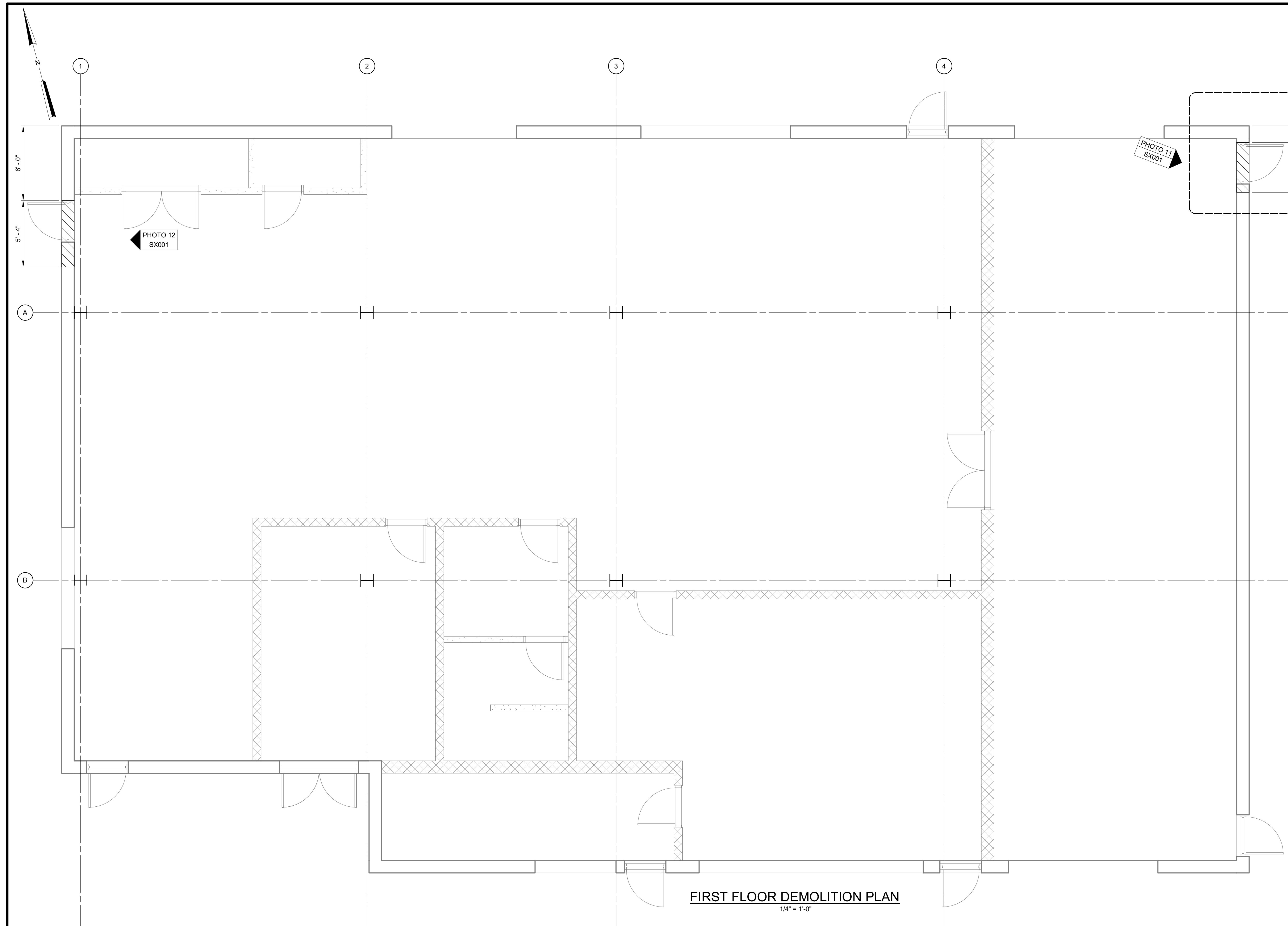


PHOTO 12  
NO SCALE  
SX001



- NOTE:
- CONTRACTOR SHALL INSTALL AND BE RESPONSIBLE FOR TEMPORARY BRACING ABOVE OPENING BEFORE CUTTING CMU BLOCK
  - CONTRACTOR SHALL FIELD VERIFY REQUIRED LOCATION, ELEVATION, AND SIZE OF OPENING AND SUBMIT PLANS TO ENGINEER FOR REVIEW

DETAIL 3  
1/2" = 1'-0"  
SX001



FIRST FLOOR DEMOLITION PLAN  
1/4" = 1'-0"

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REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET

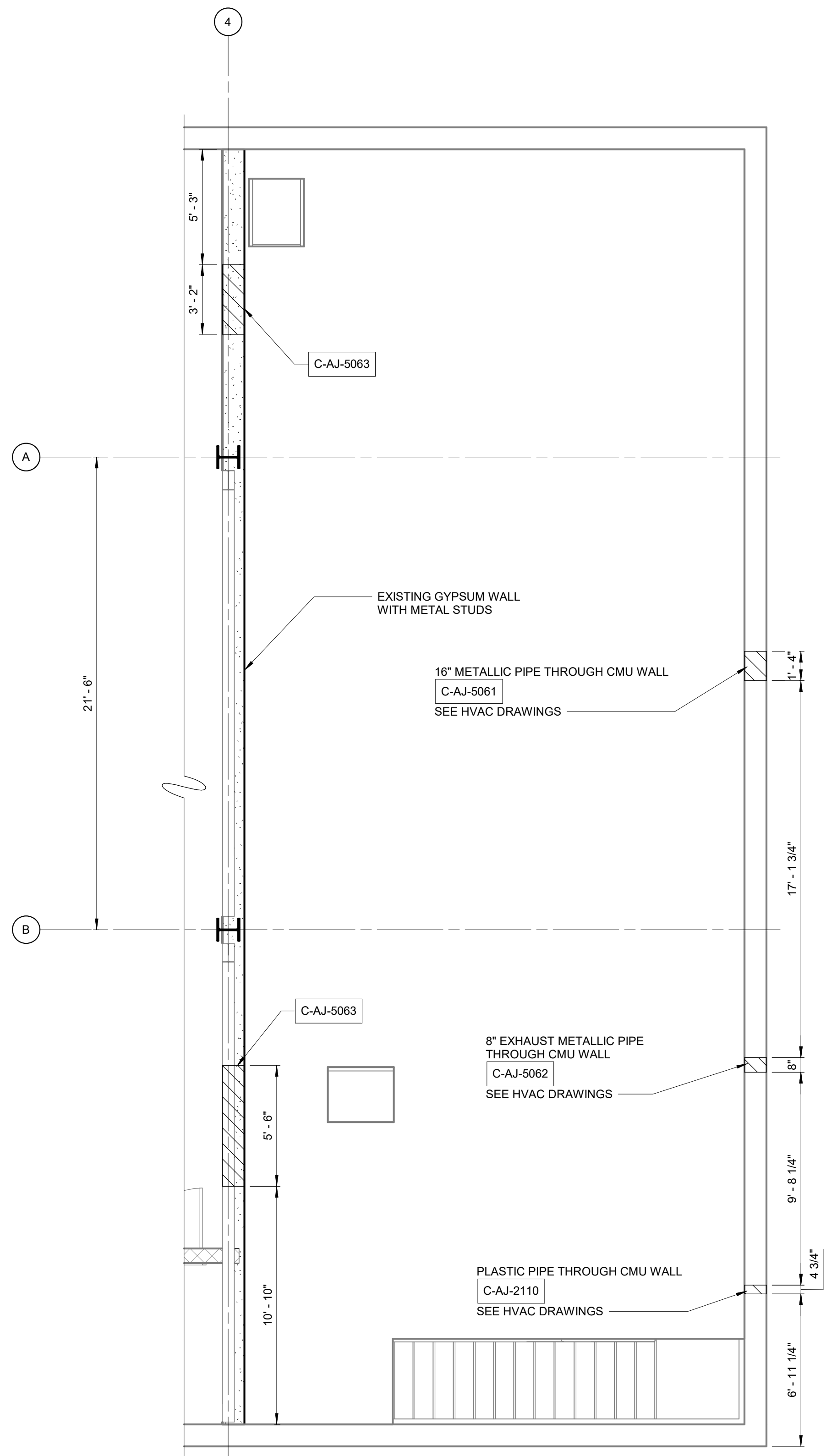
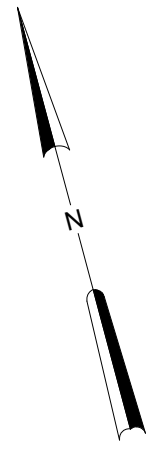


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SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
DEMOLITION PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	SX001



**MEZZANINE DEMOLITION PLAN**  
1/4" = 1'-0"

**NOTES:**

1. DEMOLISH EXISTING CMU BLOCK TO ACCOMMODATE NEW HVAC EQUIPMENT. NO OVER CUTTING BEYOND WHAT IS REQUIRED TO INSTALL THE REINFORCEMENT SHOWN ON THE NEW WORK DETAILS.
2. PATCH EXISTING MASONRY WALL AS REQUIRED TO MATCH EXISTING. ANY DAMAGE TO EXISTING MASONRY WALL NOT INCLUDED IN THE EXTENTS OF DEMOLITION SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REPAIR AND/OR RESTORE.
3. LOCATION OF NEW OPENINGS IN CMU WALLS SHALL BE FIELD VERIFIED. ENSURE NEW OPENINGS DO NOT INTERFERE WITH EXISTING STRUCTURAL MEMBERS OR MECHANICAL EQUIPMENT. SHOULD INTERFERENCES BE IDENTIFIED, CONTRACTOR SHALL NOTIFY ENGINEER PRIOR TO DEMOLITION.

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REV	ISSUED FOR	DATE	CNT	BY
1	BID SET	10/2024	CNT	

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST

BID SET

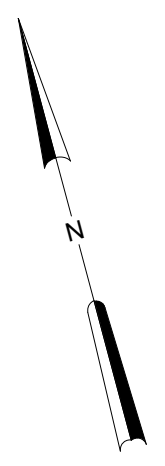


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10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

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SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

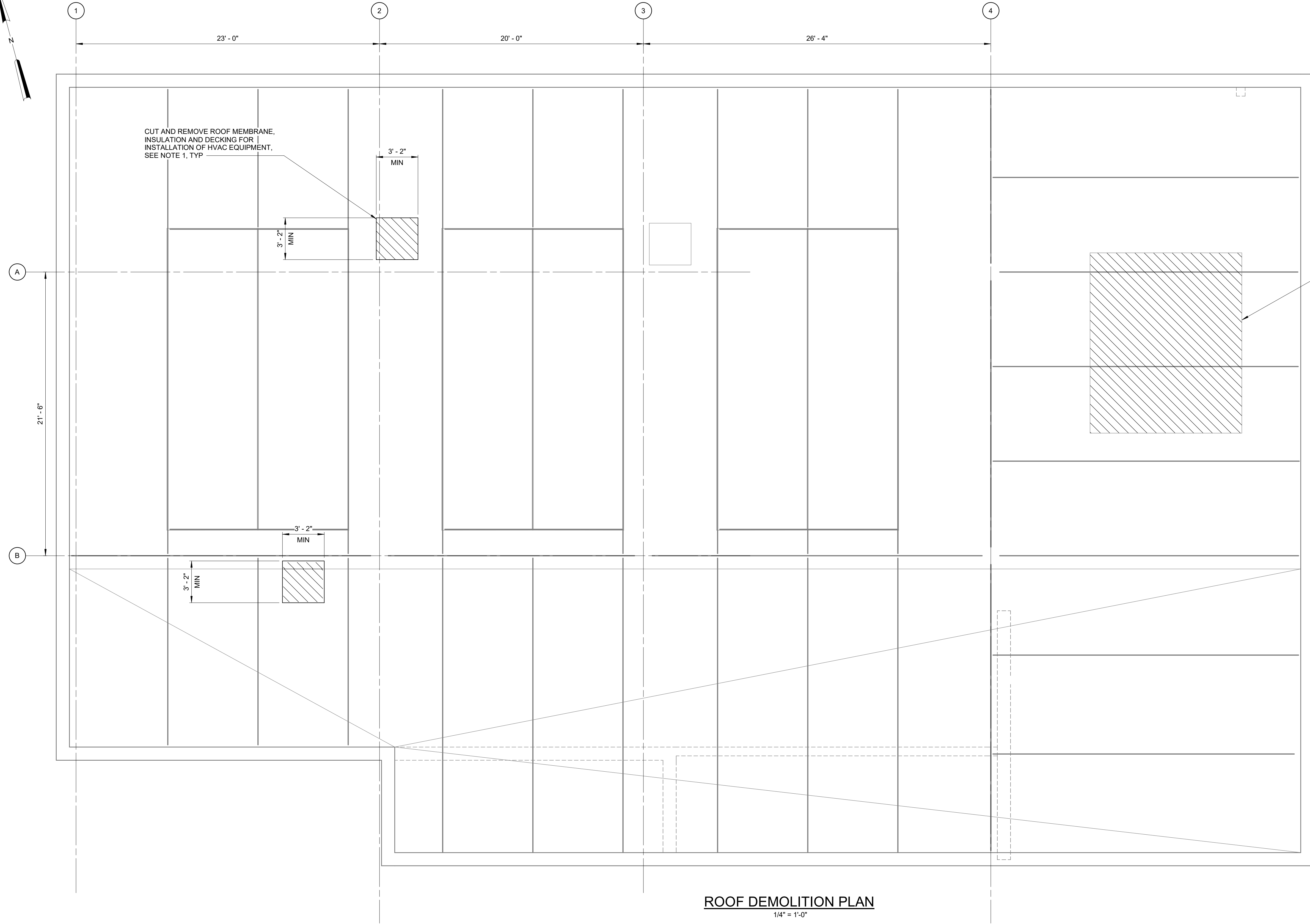
STRUCTURAL  
DEMOLITION PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	SX002

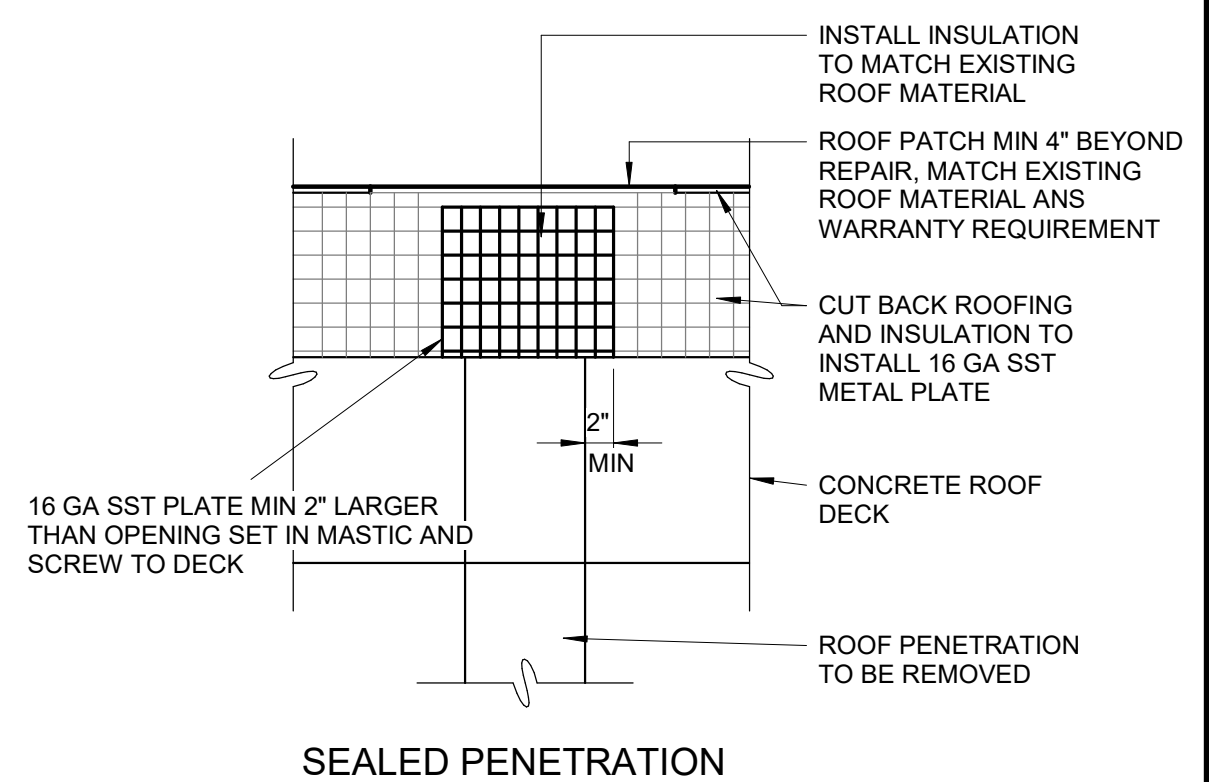


**NOTES:**

- CONTRACTOR SHALL FIELD VERIFY LOCATION OF OPENINGS WITH NEW HVAC EQUIPMENT. EXISTING FRAMING SYSTEM SHALL REMAIN IN TACT. ENGINEER SHALL BE NOTIFIED IMMEDIATELY OF ANY INTERFERENCES WITH NEW OPENINGS, NEW HVAC EQUIPMENT AND EXISTING ROOF FRAMING.



REMOVE EXISTING ROOF HATCH, REPAIR AND SEAL INSULATION AS REQUIRED



<b>DETAIL</b>	<b>5</b>
NTS	SX003

**ROOF DEMOLITION PLAN**  
1/4" = 1'-0"

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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET

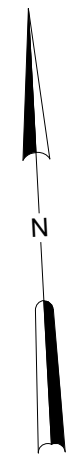


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SUITE 130, SOUTH JORDAN, UT 84095

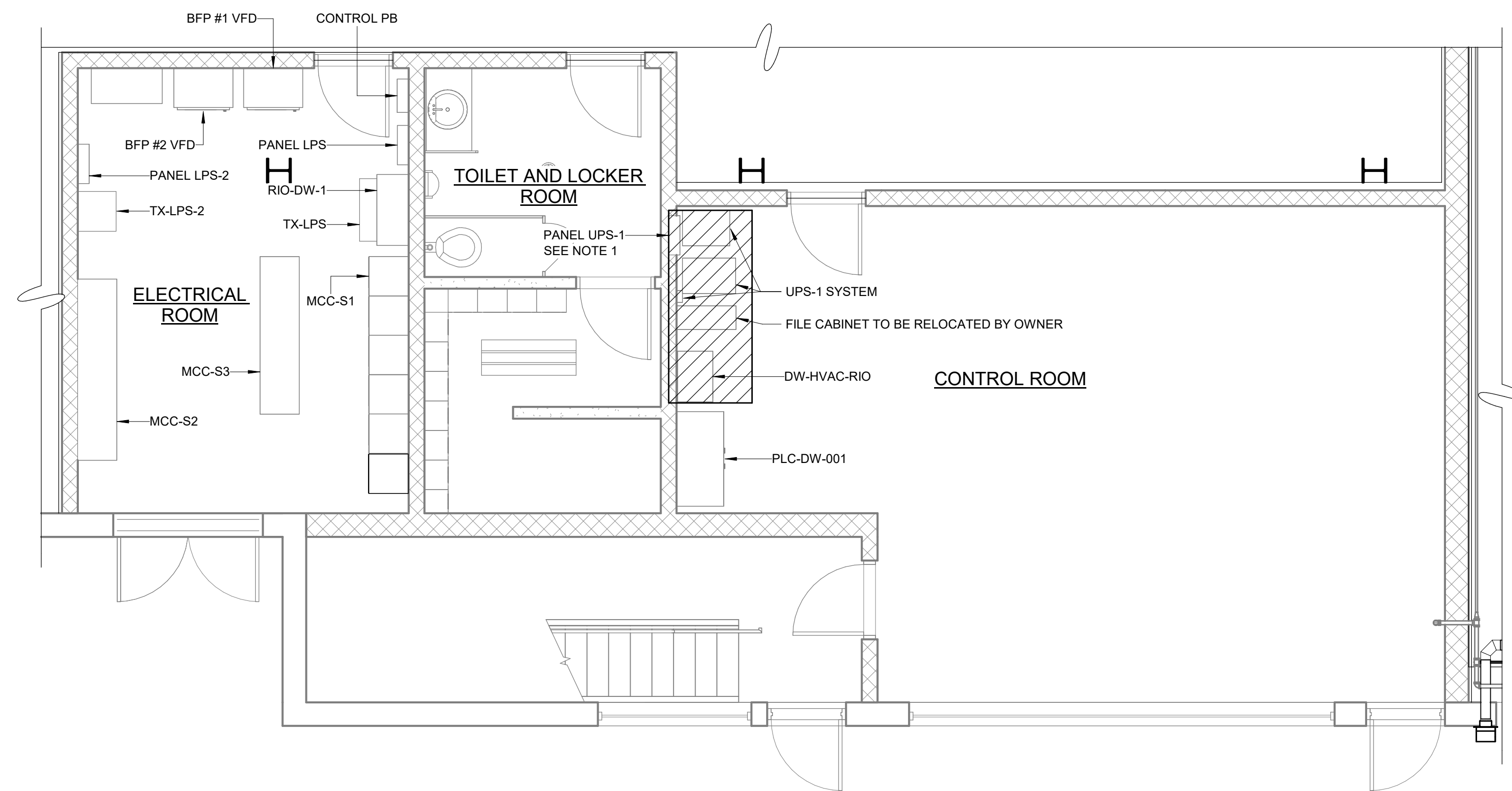
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
DEMOLITION PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	SX003



- NOTES:
1. CONTRACTOR SHALL REPAIR AND PAINT WALL AFTER REMOVING RECESSED LIGHTING PANEL UPS-1. MATCH EXISTING PAINT AND PAINT ENTIRE WALL.
  2. CONTRACTOR SHALL REPLACE EXISTING LIGHT FIXTURES IN THE FOLLOWING AREAS (NOT SHOWN ON THIS PLAN): POLYMER CONTAINMENT AREA, PUMP ROOM, TRUCK BAY, PRESS ROOM, COMPRESSOR ROOM, AND MECHANICAL ROOM. SEE NEW WORK PLANS FOR DETAILS.



PARTIAL FIRST FLOOR PLAN  
1/4" = 1'-0"

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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

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10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

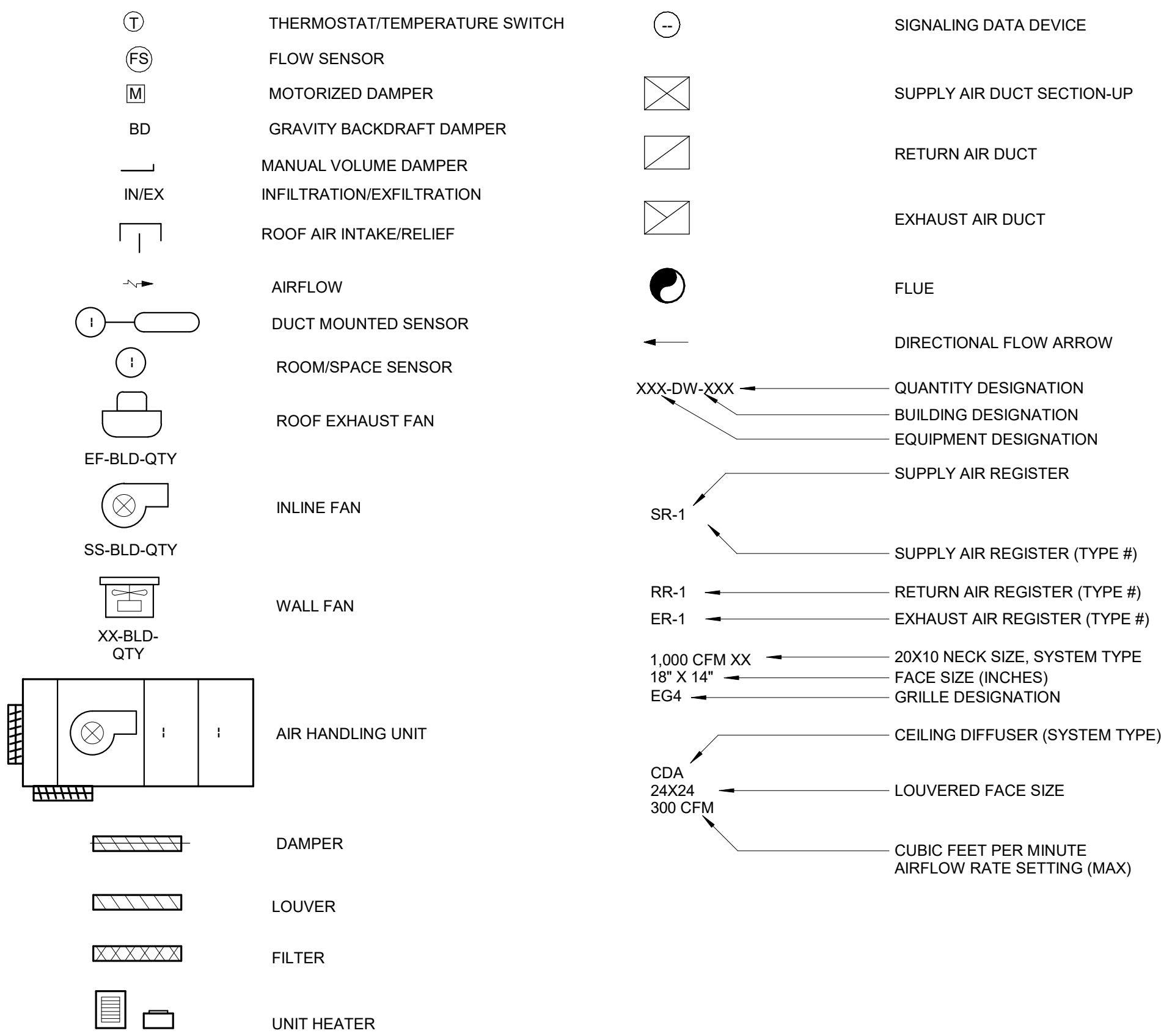
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
DEMOLITION - FIRST FLOOR

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	EX001



**SYMBOLS**



**ABBREVIATIONS**

AI	ANALOG INPUT	NC	NORMALLY CLOSED, NOISE CRITERIA
AC	AIR CONDITIONING, AIR CONDITIONING UNIT	N.I.C.	NOT IN CONTRACT
ACCU	AIR COOLED CONDENSING UNIT	NK	NECK
ACC	AIR COOLED CONDENSER	NO	NORMALLY OPEN
AD	ACCESS DOOR	NTS	NOT TO SCALE
AF	ABOVE FINISHED FLOOR	OA	OUTSIDE AIR
AFUE	ANNUAL FUEL UTILIZATION EFFICIENCY	OAI	OUTSIDE AIR INTAKE
AHU	AIR HANDLING UNIT	ORP	OXYGEN REDUCTION POTENTIAL
AO	ANALOG OUTPUT	P	PUMP
APD	AIR PRESSURE DROP	PC	PLUMBING CONTRACTOR
ATC	AUTOMATIC TEMPERATURE CONTROL	PD	PRESSURE DROP
ATU	AIR TERMINAL UNIT	PF	PROPELLER FAN
B	BOILER	PH, Ø	PHASE
BD	GRAVITY BACKDRAFT DAMPER	PPU	POSITIVE PRESSURIZATION UNIT
BFP	BACKFLOW PREVENTER	PROP	PROPELLER
BHP	BRAKE HORSEPOWER	PRV	PRESSURE REGULATING VALVE
BOD	BOTTOM OF DUCT	PTAC	PACKAGED TERMINAL AIR CONDITIONING UNIT
BOR	BOTTOM OF REGISTER	PS	PRESSURE SENSOR
BOT	BOTTOM	PW	POTABLE WATER
CB	CIRCUIT BREAKER	RA	RETURN AIR
CFM	CUBIC FEET OF STANDARD AIR PER MINUTE	RH	RELATIVE HUMIDITY
CH	CABINET UNIT HEATER	RL	REFRIGERANT LIQUID
CLG	CEILING	RLA	RATED LINE AMPS
CONN	CONNECTION	RS	REFRIGERANT SUCTION
CWS	CHILLED WATER SUPPLY	RPM	REVOLUTIONS PER MINUTE
CWR	CHILLED WATER RETURN	SA	SUPPLY AIR
DI	DIGITAL INPUT	SD	SMOKE DETECTOR
DB	DRY BULB	SF	SUPPLY AIR FAN
DDC	DIRECT DIGITAL CONTROL	SG	SUPPLY GRILLE
DX	DIRECT EXPANSION REFRIGERANT	SHR	SENSIBLE HEAT RATIO
DIA, Ø	DIAMETER	SP	STATIC PRESSURE
DM	DAMPER MOTOR	SPEC	SPECIFICATION
DN	DOWN	SS	STAINLESS STEEL
DO	DIGITAL OUTPUT	SV	SOLENOID VALVE
EA	EXHAUST AIR	TEMP	TEMPERATURE
EC	ELECTRICAL CONTRACTOR	TF	TRANSFER FAN
EAT	ENTERING AIR TEMPERATURE	TH	TOTAL HEAT
EDH	ELECTRIC DUCT HEATER	TOD	TOP OF DUCT
EG	EXHAUST GRILLE	TOU	TOP OF UNIT
EUH	ELECTRIC UNIT HEATER	TOR	TOP OF REGISTER
EF	EXHAUST FAN	TSP	TOTAL STATIC PRESSURE
EL/ELEV	ELEVATION	TS	TEMPERATURE SENSOR
ES	ENTHALPY SENSOR	TYP	TYPICAL
ESP	EXTERNAL STATIC PRESSURE	UH	UNIT HEATER
ET	EXPANSION TANK	V	VOLTS
EWT	ENTERING WATER TEMPERATURE	VAV	VARIABLE AIR VOLUME
EXH	EXHAUST	VD	VOLUME DAMPER
FA	FREE AREA	VEL	VELOCITY
FC	FORWARD CURVED OR FAN COIL	VH	HEATING CONTROL VALVE
FD	FIRE DAMPER WITH ACCESS DOOR	VC	COOLING CONTROL VALVE
FLA	FULL LOAD AMPS	VFD	VARIABLE FREQUENCY DRIVE
FOR	FUEL OIL RETURN	VVT	VARIABLE VOLUME AND VARIABLE TEMPERATURE
FOS	FUEL OIL SUPPLY	WPD	WATER PRESSURE DROP
FOV	FUEL OIL VENT	W	WASTE
FPM	FEET PER MINUTE	W/	WITH
FTR	FINNED TUBE RADIATION	WB	WET BULB
GC	GENERAL CONTRACTOR	WC	WATER COLUMN
GPM	GALLONS PER MINUTE		
HG	HOT GAS		
HP	HORSEPOWER OR HEAT PUMP		
HV	HEATING AND VENTILATING UNIT		
HWS	HOT WATER SUPPLY		
HWR	HOT WATER RETURN		
IDEC	INDIRECT EVAPORATIVE COOLING		
IDH	INLINE DUCT HEATER		
IN. WG	INCHES OF WATER GAGE		
KW	KILOWATT (1,000 WATTS)		
L1	LOUVER (TYPE 1)		
LAT	LEAVING AIR TEMPERATURE		
LD1	LINEAR DIFFUSER (TYPE 1)		
LF	LINEAR FEET		
LR	LINEAR RETURN		
LWT	LEAVING WATER TEMPERATURE		
MAU	MAKEUP AIR UNIT		
MBH	1,000 BTU PER HOUR		
MC	MECHANICAL CONTRACTOR		
MCA	MINIMUM CIRCUIT AMPACITY		
MCD	MOISTURE CODENSATE DRAIN		
MD	MOTORIZED DAMPER		
MVD	MANUAL VOLUME DAMPER		
MTD	MOUNTED		

**GENERAL NOTES**

- WORK SHALL BE EXECUTED IN FULL COMPLIANCE WITH THE APPLICABLE PROVISIONS OF ALL LAWS, BY-LAWS, STATUTES, ORDINANCES, CODES, RULES, REGULATIONS, AND LAWFUL ORDERS OF PUBLIC AUTHORITIES BEARING ON THE PERFORMANCE AND EXECUTION OF THE WORK.
- THE ENTIRE HVAC SYSTEM SHALL BE IN ACCORDANCE WITH THE FOLLOWING CODES:
  - CITY OF MARRIOTT - SLATERVILLE CODES
  - 2021 INTERNATIONAL EXISTING BUILDING CODE
  - 2021 INTERNATIONAL BUILDING CODE WITH UTAH STATE LAWS AND LOCAL AMENDMENTS.
  - 2021 INTERNATIONAL MECHANICAL CODE WITH UTAH STATE LAWS AND LOCAL AMENDMENTS.
  - 2021 INTERNATIONAL FUEL GAS CODE WITH UTAH STATE LAWS AND LOCAL AMENDMENTS.
  - 2021 INTERNATIONAL ENERGY CONSERVATION CONSTRUCTION CODE WITH UTAH STATE LAWS AND LOCAL AMENDMENTS.
  - 2021 INTERNATIONAL FIRE CODE WITH UTAH STATE LAWS AND LOCAL AMENDMENTS.
- THE SYMBOLS AND ABBREVIATIONS LIST ON THIS SHEET IS A COMPREHENSIVE STANDARD GUIDE INTENDED FOR GENERAL USE ON ALL PROJECTS. THEREFORE, NOT ALL THE SYMBOLS AND ABBREVIATIONS CONTAINED IN THIS LIST ARE NECESSARILY USED ON THIS PARTICULAR PROJECT AND SHOULD BE USED FOR CLARIFICATION ONLY.
- ALL DUCT DIMENSIONS ARE CLEAR DIMENSIONS TO INSIDE OF DUCT. DIMENSIONS TO DUCTS FROM FLOOR OR WALL SHALL BE TO THE OUTSIDE OF DUCT/INSULATION. WHERE INTERNAL INSULATION IS REQUIRED THE DUCT SIZE SHALL BE INCREASED TO GIVE CLEAR INSIDE DIMENSIONS AS NOTED ON THE DRAWINGS.
- EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE. ACTUAL DIMENSIONS TO BE DETERMINED BY EQUIPMENT FURNISHED. COORDINATE HVAC WORK WITH THE WORK OF ALL OTHER TRADES.
- FINAL OPENING DIMENSIONS, CONCRETE PAD SIZES, AND LOCATIONS MUST BE COORDINATED DURING CONSTRUCTION WITH APPROVED EQUIPMENT.
- FINAL SIZES OF FLOOR OPENINGS, DUCT PLENUMS, TRANSITIONS AND PIPING CONNECTIONS TO ALL EQUIPMENT SHALL BE DETERMINED BY EQUIPMENT FURNISHED.
- THE DRAWINGS ARE SCHEMATIC IN NATURE AND SHOW INTENDED GENERAL LOCATION OF HVAC EQUIPMENT AND SYSTEMS. NOT ALL OFFSETS AND REQUIRED FITTINGS FOR ACTUAL FIELD INSTALLATION ARE INTENDED TO BE SHOWN FOR INSTALLATION OF SYSTEMS IN THE SPACE AVAILABLE IN CONSIDERATION OF WORK OF OTHER TRADES AND FIELD CONDITIONS. CONTRACTOR SHALL PROVIDE ADDITIONAL OFFSETS IN DUCTWORK AND PIPING AS REQUIRED TO AVOID SUCH INTERFERENCES OR FIELD CONDITIONS AT NO ADDITIONAL COST TO THE ORIGINAL CONTRACT AMOUNT.
- FIRST FIGURE OF DUCT SIZE INDICATES DIMENSION OF FACE SHOWN OR INDICATED OR WIDTH OF DUCT IN PLAN VIEW.
- COORDINATE THE REQUIREMENTS FOR HVAC OPENINGS AND SLEEVES IN BUILDING ELEMENTS WITH THE GC.
- CONTRACTOR SHALL REFER TO SPECIFICATION SECTION 099000 FOR PAINTING REQUIREMENTS UNLESS OTHERWISE NOTED.
- REFER TO ELECTRICAL DRAWINGS OR SPECIFICATIONS FOR INTERLOCKING WIRING REQUIREMENTS.
- CONTRACTOR SHALL COORDINATE DUCTWORK INSTALLATION WITH OTHER TRADES.
- PROVIDE ADEQUATE SUPPORT, PER THE MANUFACTURER'S RECOMMENDATIONS, FOR ALL HVAC EQUIPMENT.
- CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING ELECTRICAL RATINGS FROM CERTIFIED DRAWINGS OF EQUIPMENT AND SHALL MAKE ANY BRANCH CIRCUIT DISTRIBUTION MODIFICATION REQUIREMENTS WITHOUT ANY ADDITIONAL COST TO OWNER. THE CONTRACTOR SHALL SUBMIT A SCHEDULE OF SUCH CHANGES FOR APPROVAL BY ENGINEER.
- WHEREVER THE REQUIREMENTS AND REGULATIONS OF STATE, FEDERAL AND LOCAL AUTHORITIES HAVING JURISDICTION DIFFER FROM THE DRAWINGS OR SPECIFICATIONS, THEY SHALL TAKE PRECEDENCE AND SHALL BE MADE PART OF THE CONTRACT (EXCEPT WHERE THE DRAWINGS OR SPECIFICATIONS ARE MORE STRINGENT).
- THE CONTRACTOR SHALL PROVIDE AND INSTALL FIRE AND SMOKE RATED DAMPERS IN HVAC DUCTS WHICH PENETRATE FIRE RATED BUILDING ASSEMBLIES AS SHOWN ON ARCHITECTURAL DRAWINGS.
- DUCTWORK AND PLENUM TO LOUVERS SHALL BE CONNECTED TO FRAMED OPENINGS AND, SEALED AIRTIGHT AND WEATHER RESISTANT.
- THERMOSTATS, SENSORS, AND/OR CONTROL PANEL LOCATIONS SHOWN ARE APPROXIMATE AND SHALL BE COORDINATED TO SUIT FIELD CONDITIONS.
- INSTALL WALL MTD SENSORS, CONTROLS AND THERMOSTATS 5'-0" AFF UNLESS OTHERWISE NOTED. ALIGN WITH OTHER NEARBY ITEMS SUCH AS LIGHT SWITCHES. DO NOT INSTALL CLOSER THAN 6-INCHES FROM EDGE OF DOOR FRAME OR CORNER OF WALL AS SHOWN ON ARCH PLANS. WHERE CONFLICTS MAY OCCUR WITH ITEMS SUCH AS LIGHT SWITCHES, MOUNT THE SENSOR OR CONTROL DEVICE 4'-6" AFF CENTERED ABOVE THE LIGHT SWITCH.
- PROVIDE ADEQUATE MEANS OF ACCESS CLEARANCE FOR ALL HVAC/MECHANICAL EQUIPMENT AND SYSTEMS THAT REQUIRE ACCESS FOR PROPER OPERATION, MAINTENANCE AND REPAIR PER RECOMMENDED MANUFACTURER CLEARANCES. PROVIDE ACCESS DOORS WHERE NECESSARY IN FINISHED WALLS OR DRYWALL CEILINGS FOR ACCESS TO VALVES, DAMPERS, OR CONTROL DEVICES.
- COORDINATE THE REQUIREMENTS OF HVAC HANGERS AND SUPPORTS W/ OTHER PRIME CONTRACTORS PROVIDING STRUCTURAL AND/OR ARCHITECTURAL BUILDING ELEMENTS WHICH HVAC SUPPORTS SHALL INTERFACE.
- HVAC CONTRACTOR SHALL PROVIDE ALL FIRESTOPPING AND PIPE SLEEVES FOR ALL PIPE AND DUCT PENETRATIONS THRU FIRE RATED BUILDING ASSEMBLIES.
- CONTRACTOR SHALL OBTAIN PERMIT. OWNER SHALL PAY ALL FEES RELATED TO PERMITTING, AND INSPECTIONS.
- FOR ADDITIONAL REQUIREMENTS REFER TO SPECIFICATIONS.
- THE CONTRACTOR SHALL COORDINATE WITH ALL OTHER TRADES TO ENSURE ALL AIR CONDITIONING EQUIPMENT, DUCTWORK, PIPING AND RELATED APPURTENANCES ARE NOT LOCATED ABOVE ELECTRICAL EQUIPMENT.

**LINETYPES**

—————	NEW - HVAC
—————	NEW - ALL ADDITIONAL DISCIPLINES
-----	NEW - HIDDEN
- - - - -	VENT
-----	EXISTING - HIDDEN
—————	EXISTING - ALL DISCIPLINES

Autosave: Doc: 7/01/23 00:00\_CNSID Dewatering Building HVAC Improv/7/01/23 00:00\_CNSID-H&P.rvt 10/21/2024 6:08:23 PM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE

BID SET



**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

**CENTRAL WEBER**  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
**DEWATERING BUILDING HVAC IMPROVEMENTS**

**HVAC**  
GENERAL NOTES, LEGEND, AND ABBREVIATIONS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H001



NFPA 820 (2020 EDITION) CLASSIFICATION AND VENTILATION

ROOM, STRUCTURE, OR AREA	NFPA 820 TABLE 6.2.2 (a)	FUNCTION	EXTENT OF CLASSIFIED AREA	INITIAL AREA CLASSIFICATION	VENTILATION RATE	FINAL AREA CLASSIFICATION	PRESSURIZATION	ROOM VOLUME CU FT	O.A. REQ. CFM	O.A. SUPPLY CFM	EXHAUST CFM
PRESS ROOM	ROW 12.a	DEWATERING BUILDINGS CONTAINING CENTRIFUGES, GRAVITY BELT THICKENERS, BELT AND VACUUM FITLER AND BELT PRESSES - FILTER PRESS	ENTIRE ROOM	CLASS I, DIVISION 2	6 ACH	UNCLASSIFIED	NEGATIVE 0.1 IN WC	103,357	10,336	9,350	10,350
PUMP ROOM	ROW 9.b	SLUDGE PUMPING STATION DRY WELLS	ENTIRE ROOM	CLASS I, DIVISION 2	6 ACH	UNCLASSIFIED	NEGATIVE 0.1 IN WC	43,785	4,379	3,960	4,400
TRUCK BAY	ROW 13.a	ENCLOSED CAKE STORAGE	ENTIRE ROOM	CLASS I, DIVISION 2	6 ACH	UNCLASSIFIED	NEGATIVE 0.1 IN WC	23,354	2,335	2,110	2,350

NOTES:

- ALL SPACES CONNECTED TO A CLASSIFIED AREA WILL HAVE THE HIGHEST LEVEL OF CLASSIFICATION OF THE CONNECTED SPACES.
- SUMMER VENTILATION RATES SHOWN ON PLAN EXCEED NFPA VENTILATION RATES BY 50%.

AIR HANDLING UNITS

TAG	LOCATION	MANUFACTURER		AREAS SERVED	MAXIMUM SUPPLY AIRFLOW (CFM)	NORMAL SUPPLY AIRFLOW (CFM)	MINIMUM SUPPLY AIRFLOW (CFM)	MAXIMUM OA (%)	MAXIMUM EXHAUST AIRFLOW (CFM)	NORMAL EXHAUST AIRFLOW (CFM)	MINIMUM EXHAUST AIRFLOW (CFM)	SUPPLY FAN CHARACTERISTICS							MOTOR				EXHAUST FAN CHARACTERISTICS							MOTOR				INDIRECT GAS FIRED HEATING					
		MAKE	MODEL									WHEEL TYPE	WHEEL DIA. (IN)	MAX AIRFLOW PER FAN (CFM)	TSP (*WG)	ESP (*WG)	SPEED (RPM)	QTY	BHP	HP	VFD	WHEEL TYPE	WHEEL DIA. (IN)	MAX AIRFLOW PER FAN (CFM)	TSP (*WG)	ESP (*WG)	SPEED (RPM)	QTY	BHP	HP	VFD	CAPACITY INPUT / OUTPUT (MBH)	EAT (°F)	LAT (°F)	MAX. FACE VEL. (FPM)	AIRFLOW AT MAX HEATING (CFM)	MAX. AIR P.D. (*WG)	FUEL TYPE	CONNECTION SIZE (IN)
MAU-DW-001	MECH RM	INNOVENT	ERU-OU-PL-21000-1F-DV-460	PRESS AND PUMP ROOMS	21,040	14,400	8,485	100	18,145	10,075	2,190	PLENUM	22	10,520	4.7	2	2189	2	11.5	15	YES	PLENUM	18	6,049	2.99	1.25	2328	3	4.7	7.5	YES	1,436 / 1,150	12.6	69.4	600	18,735	0.69	NG	2

NOTES:

- REFER TO SPECIFICATION 23 75 00
- REFER TO COIL SCHEDULE FOR HEAT RECOVERY COIL.
- ALUMINUM CONSTRUCTION
- SUPPLY FANS ARE TO BE DESIGNATED SF-DW-001 AND SF-DW-002.
- EXHAUST FANS ARE TO BE DESIGNATED EF-DW-006, EF-DW-007, AND EF-DW-008.

AIR HANDLING UNITS - CONT.

EVAPORATIVE COOLING COIL							POWER						WEIGHT (LBS)	NOTES		
EAT (°F) DB	LAT (°F) WB	SATURATION EFFICIENCY	MAKEUP WATER (GPM)	BLEED RATE (GPM)	DESIGN AIRFLOW (CFM)	MAX. FACE VEL. (FPM)	MAX. AIR P.D. (*WG)	V	PH	HZ	MCA	MOCP				
93.3	60.5	64.2	60.5	88.7	1.6	0.53	21,040	526	0.24	460	3	60	76.8	90	14,000	1,2,3,4,5

SEISMIC DESIGN REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

STRUCTURE	RISK CATEGORY	SEISMIC DESIGN CATEGORY	NON-STRUCTURAL COMPONENT	IMPORTANCE FACTOR (Ip)	DESIGN FOR SEISMIC FORCES REQUIRED	NOTES
DEWATERING BUILDING	III	D	HVAC (ALL)	1	NO	1, 2

GENERAL NOTES:

- INFORMATION BASED ON ASCE-7 2010
- INSTALLATIONS SHALL BE IN ACCORDANCE WITH CURRENT VERSIONS OF THE IBC, IPC, IMC, NEC, AND ALL LOCAL ORDINANCES

GAS CONNECTIONS

TAG	DESCRIPTION	INPUT LOAD (CFH)	CONNECTION SIZE (IN)
MAU-DW-001	MAKE-UP AIR UNIT	1,331,000	2-1/2
AC-DW-001	GAS FURNACE	96,000	3/4
TOTAL CONNECTED LOAD		1,427,000	2-1/2

NOTES:

- LOW PRESSURE GAS SIZED PER IFGC TABLE 403.4(2) LESS THAN 2 PSIG WITH 0.5" W.C. LOSS FOR 150 EQUIVALENT FEET.

DESIGN TEMPERATURE CONDITIONS

	SUMMER	WINTER
OUTDOOR AMBIENT CONDITIONS	93.3 F DB / 60.5 F WB	12.6 F DB
ALL AREAS	104.0 F DB	65.0 F DB

OUTDOOR DESIGN TEMPERATURES BASED UPON ASHRAE 2021 CLIMATIC DESIGN DATA FOR THE 99.0 PERCENTILE HEATING DRY BULB INDICENCE AND THE 1.0 PERCENTILE COOLING DRY BULB AND WET BULB INDICENCES: OGDEN HINCKLEY, OGDEN, UTAH (WMO: 725750)

HEAT RECOVERY COIL

TAG	LOCATION	MANUFACTURER		TYPE	OCCUPIED HEATING AIRFLOW (CFM O/A/E)	UNOCCUPIED HEATING AIRFLOW (CFM O/A/E)	OCCUPIED OA HEATING		UNOCCUPIED OA HEATING		OCCUPIED EXHAUST HEATING		UNOCCUPIED EXHAUST HEATING		OCCUPIED OUTSIDE AIR P.D. (IN W.C.)	OCCUPIED EXHAUST P.D. (IN W.C.)	UNOCCUPIED OUTSIDE AIR P.D. (IN W.C.)	UNOCCUPIED EXHAUST P.D. (IN W.C.)	MAX. FACE VEL. (FPM)	NOTES
		EAT (°F, DB/WB)	LAT (°F, DB/WB)				EAT (°F, DB/WB)	LAT (°F, DB/WB)	EAT (°F, DB/WB)	LAT (°F, DB/WB)	EAT (°F, DB/WB)	LAT (°F, DB/WB)								
HX-DW-001	MECH RM	INNOVENT	H-1-40B-1800	PLATE	14,400 / 10,075	8,485 / 4,090	9.2 / 6.0	44.5 / 29.4	9.2 / 6.0	48.6 / 32.8	70.0 / 57.8	34.6 / 34.6	70.0 / 57.8	46.3 / 46.3	1.07	0.74	0.25	0.31	600	1,2

NOTES:

- REFER TO SPECIFICATION 23 75 00 FOR ADDITIONAL REQUIREMENTS.
- INTEGRAL TO DB-MAU-1

GAS UNIT HEATERS

TAG	LOCATION	MANUFACTURER		TYPE	INPUT CAPACITY (MBH)	OUTPUT CAPACITY (MBH)	AIRFLOW (CFM)	TEMP. RISE (F)	HEAT THROW (FT)	DIMENSIONS			WEIGHT (LBS)	POWER			NOTES
		MAKE	MODEL							WIDTH (IN)	HEIGHT (IN)	DEPTH (IN)		VOLT	PH	HZ	
JH-DW-001	TRUCK BAY	MODINE	PDP 175	POWER VENT	175	143.5	2,550	51	59	21	23.5	29.6	200	120	1	60	1, 2, 3
JH-DW-002	TRUCK BAY	MODINE	PDP 175	POWER VENT	175	143.5	2,550	51	59	21	23.5	29.6	200	120	1	60	1, 2, 3

NOTES:

- REFER TO SPECIFICATION 23 55 33 FOR ADDITIONAL REQUIREMENTS.
- WALL MOUNTED THERMOSTAT
- MOUNTING BRACKET

FANS

TAG	LOCATION	AREA SERVED	MANUFACTURER		AIRFLOW (CFM)	E.S.P. (*WG)	FAN		WHEEL TYPE	MAX. SPEED (RPM)	MOTOR			POWER			WEIGHT (LBS)	NOTES	
			MAKE	MODEL			TYPE	DRIVE			MIN. DIA.	BHP	HP	VFD	VOLT	PH			HZ
EF-DW-001	PUMP RM	PUMP RM	HARTZELL	A09SH-363-L	1,760	0.5	WALL PROP	BELT	PROP	42	1,585	0.7	1	NO	480	3	60	440	1, 3
EF-DW-002	ROOF	PRESS ROOM	HARTZELL	A88-0-301FE100	5,000	0.5	FRP UPBLAST	BELT	CENT	36	925	0.9	1.5	NO	480	3	60	435	1, 2
EF-DW-003	ROOF	PRESS ROOM	HARTZELL	A88-0-301FE100	5,000	0.5	FRP UPBLAST	BELT	CENT	36	925	0.9	1.5	NO	480	3	60	435	1, 2
EF-DW-004	ROOF	PRESS ROOM	HARTZELL	A88-0-301FE100	5,000	0.5	FRP UPBLAST	BELT	CENT	36	925	0.9	1.5	NO	480	3	60	435	1, 2
EF-DW-006	MECH RM	DEWATERING BUILDING	REFER TO MAU SCHEDULE																
EF-DW-007	MECH RM	DEWATERING BUILDING	REFER TO MAU SCHEDULE																
EF-DW-008	MECH RM	DEWATERING BUILDING	REFER TO MAU SCHEDULE																
EF-DW-009	TRUCK BAY	TRUCK BAY	HARTZELL	A09SH-363-L	1,760	0.5	WALL PROP	BELT	PROP	36	1,585	0.7	1	NO	480	3	60	440	1, 3
EF-DW-010	TRUCK BAY	TRUCK BAY	HARTZELL	A09SH-363-L	1,765	0.5	WALL PROP	BELT	PROP	36	1,585	0.7	1	NO	480	3	60	440	1, 3
SF-DW-001	MECH RM	DEWATERING BUILDING	REFER TO MAU SCHEDULE																
SF-DW-002	MECH RM	DEWATERING BUILDING	REFER TO MAU SCHEDULE																
SF-DW-003	TRUCK BAY	TRUCK BAY	HARTZELL	A38--443-L	3,180	0.75	INLINE	BELT	CENT	44	1,300	1.7	2	NO	480	3	60	450	1, 3, 5

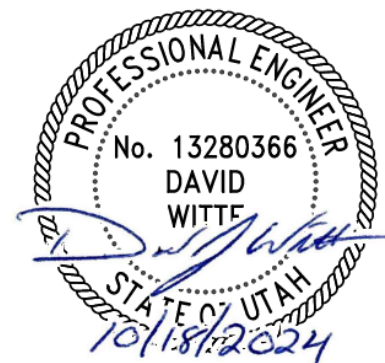
NOTES:

- REFER TO SPECIFICATION 23 34 00
- INSULATED ROOF CURB
- WALL HOUSING
- REFER TO MAKE-UP AIR UNIT SCHEDULE FOR SF-DW-001, SF-DW-002, EF-DW-008, EF-DW-009, AND EF-DW-010
- TWO SPEED MOTOR

Autodesk Docs/70123-000\_CVNSID Dewatering Building HVAC Improv/70123-000-200-CVNSID-HBP.rvt 10/23/2024 6:08:23 PM

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	P. GREER
CHECKED BY:	D. WITTE
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"
1 BID SET	10/2024 CNT
REV ISSUED FOR	DATE BY

BID SET



**Hazen**

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

HVAC  
SCHEDULES

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H002

**AIR HANDLING UNITS**

TAG	LOCATION	MANUFACTURER		TYPE	AREA SERVED	AIR FLOW (CFM)	MIN. OA (CFM)	E.S.P. ("WG)	DESIGN TOTAL CAPACITY (MBH)	DESIGN SENSIBLE CAPACITY (MBH)	EFFICIENCY EER2	MOTOR			TYPE	EAT (°F)	HEATING COIL				COOLING COIL				WEIGHT (LBS)	POWER					NOTES			
		MAKE	MODEL									BHP	HP	VFD			LAT (°F)	CAPACITY (MBH) AT 17°F	MAX. FACE VEL. (FPM)	AIRFLOW AT MAX HEATING (CFM)	EAT (°F)	DB	WB	DB		WB	MAX. FACE VEL. (FPM)	MAX. AIR P.D. ("WG)	CAPACITY (TOTAL) (MBH)	VOLT		PH	HZ	MCA
AC-DW-001	MECHANICAL ROOM	TRANE	S9X1C080U5PSB	FURNACE W/ DX	MECHANICAL ROOM	1750	190	0.4	60000	45985	11.7	0.86	1	NO	NAT GAS / HP	58.2	100.2	77,600	500	1750	82.5	64.4	54.2	46.6	500	0.1	60000	206	120	1	60	14.1	15	1, 3, 4
AC-DW-002	COMPRESSOR ROOM	MITSUBISHI	PKA-A24KA8	MINI-SPLIT	COMPRESSOR ROOM	775	0	0.2	24000	18480	12.2	0.09	1/10	NO	HEAT PUMP	68	86.8	15,700	500	775	81.2	46.5	54.6	33.6	500	0.05	2400	46	208	1	60	1	26	1, 2

- NOTES:  
 1. REFER TO SPECIFICATION 23 81 26 FOR ADDITIONAL REQUIREMENTS.  
 2. INDOOR UNIT POWER BY OUTDOOR UNIT.  
 3. TRANE 4PXCCU60BS3 COOLING COIL  
 4. PROVIDE WITH ACID NEUTRALIZER

**AIR COOLED CONDENSING UNIT**

TAG	LOCATION	MANUFACTURER		TYPE	DESIGN CAPACITY (MBH)	COMPRESSOR TYPE	CONDENSER		EFFICIENCY EER2	AMBIENT TEMP.		MAXIMUM ASSEMBLED DIMENSIONS (L x W x H)	WEIGHT (LBS)	POWER					NOTES
		MAKE	MODEL				FAN NO.	FAN TYPE		MAX.	MIN.			VOLT	PH	HZ	MCA	MOCP	
CU-DW-001	ROOF	TRANE	4TWA4060A4	HEAT PUMP	60000	SCROLL	1	PROP	12.3	115	0	34-1/3 x 37-1/4 x 45-1/8	248	460	3	60	9	15	1
CU-DW-002	ROOF	MITSUBISHI	PUZ-A24NH47	HEAT PUMP	24000	SCROLL	1	PROP	12.2	115	0	37-13/32 x 13 x 37-1/8	153	208	1	60	19	25	1, 2

- NOTES:  
 1. REFER TO SPECIFICATION 23 81 26 FOR ADDITIONAL REQUIREMENTS.  
 2. INDOOR UNIT POWER BY OUTDOOR UNIT.

**MIST ELIMINATOR**

TAG	LOCATION	MANUFACTURER		AIRFLOW (CFM)	FACE VELOCITY (FPM)	PRESSURE DROP (IN WC)	SIZE (IN)			MATERIAL	PITCH	SPACING (IN)	NOTES
		MAKE	MODEL				WIDTH (IN)	HEIGHT (IN)	DEPTH (IN)				
ME-DW-1	DEWATERING	MUNTERS	DF2500	6.6	600	0.12	48	36	6	316 SS	1	1	1

- NOTES:  
 1. REFER TO SPECIFICATION 23 31 13 FOR ADDITIONAL REQUIREMENTS.

**LOUVERS**

TAG	AREA SERVED	MANUFACTURER		AIRFLOW DIRECTION	TYPE	MATERIAL	AIRFLOW (CFM)	SIZE			FREE AREA (SQFT)	FACE VEL. (FPM)	STATIC P.D. ("WG)	NOTES
		MAKE	MODEL					WIDTH (IN)	HEIGHT (IN)	DEPTH (IN)				
L-DW-001	PUMP RM	RUSKIN	ELF6375	EXHAUST	STATIONARY	ALUMINUM	1,760	36	36	6	4.8	366.7	0.02	1, 2, 3
L-DW-002	TRUCK BAY	RUSKIN	ELF6375	INTAKE	STATIONARY	ALUMINUM	2,350	36	30	6	3.87	607.2	0.07	1, 2, 3

- NOTES:  
 1. REFER TO SPECIFICATION 23 31 13 FOR ADDITIONAL REQUIREMENTS.  
 2. FLANGE MOUNTING.  
 3. KYNAR COATING, COLOR SELECT TO MATCH BUILDING.

**AIR DEVICES - DIFFUSERS, REGISTERS, AND GRILLES**

TAG	AREA SERVED	MANUFACTURER		AIRFLOW RANGE (CFM)	NECK SIZE (IN)	FACE SIZE		MAX PRESS. DROP ("WG)	TYPE	MATERIAL	MOUNTING SURFACE	NOTES
		MAKE	MODEL			W (IN)	H (IN)					
EG1	PUMP RM	TITUS	350	365 - 735	24X10	24	10	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
EG2	PUMP RM	TITUS	350	365 - 735	16X16	16	16	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
EG3	PRESS RM	TITUS	350	260 - 700	18X10	18	10	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
EG4	PRESS RM	TITUS	350	50 - 300	12X8	12	8	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
EG5	PRESS RM	TITUS	350	950 - 2000	36X14	36	14	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
SG1	PRESS RM	TITUS	300	1110 - 3400	20X36	20	36	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
SG2	PUMP RM	TITUS	300	365-1185	32X10	32	10	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
SG3	PRESS RM	TITUS	300	1400 - 2825	24X14	24	14	0.07	HORIZONTAL	316 STAINLESS	DUCT	1
RG1	MECH RM	TITUS	350	500 - 1150	16X16	16	16	0.07	HORIZONTAL	316 STAINLESS	DUCT	1

- NOTES:  
 1. REFER TO SPECIFICATION 23 31 13 FOR ADDITIONAL REQUIREMENTS.

**CONTROL DAMPERS**

TAG	AREA SERVED	MANUFACTURER		BLADE TYPE	FAIL POSITION	MATERIAL	SIZE (IN)			ACTUATION TYPE (ELECT./ PNEUMATIC)	MAX AIRFLOW (CFM)	PRESSURE DROP MAX. ("WG)	FREE AREA (SQFT)	FACE VELOCITY (FPM)	POWER			NOTES	
		MAKE	MODEL				W	H	D						VOLT	PH	HZ		
BD-DW-001	PUMP RM.	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	36	36	3	GRAVITY	1,790	0.05	7.2	248.6	NA	NA	NA	1	
BD-DW-002	PRESS RM.	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	26	26	3	GRAVITY	5,000	0.05	3.8	1,331.4	NA	NA	NA	1	
BD-DW-003	PRESS RM.	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	26	26	3	GRAVITY	5,000	0.05	3.8	1,331.4	NA	NA	NA	1	
BD-DW-004	PRESS RM.	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	26	26	3	GRAVITY	5,000	0.05	3.8	1,331.4	NA	NA	NA	1	
BD-DW-006	TRUCK BAY	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	42	42	3	GRAVITY	1,175	0.05	9.8	119.9	NA	NA	NA	1	
BD-DW-007	TRUCK BAY	RUSKIN	CBD2	COUNTERWIEGHT	CLOSED	ALUMINUM	42	42	3	GRAVITY	1,175	0.05	9.8	119.9	NA	NA	NA	1	
MD-DW-001	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	11,000	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-002	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	11,000	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-003	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	21,040	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-004	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	21,040	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-005	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	21,040	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-006	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	11,000	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-007	DEWATERING BUILDING				REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00						ELECT.	11,000	REFER TO MAU SCHEDULE AND SPECIFICATION 23 75 00			120	1	60	1, 2
MD-DW-008	TRUCK BAY	RUSKIN	CD40	AIRFOIL	OPEN	ALUMINUM	36	30	4	ELECT.	2,350	0.05	6	391.7	120	1	60	1, 2	
MD-DW-009	MECHANICAL ROOM	RUSKIN	CDRS15	AIRFOIL	CLOSED	GALVANIZED	8 Ø	-	-	ELECT.	200	0.05	0.34	588.2	120	1	60	1, 2	
MD-DW-010	PRESS RM.	RUSKIN	CD40	AIRFOIL	OPEN	ALUMINUM	38	22	4	ELECT.	5,665	0.05	5.81	975	120	1	60	1, 2	

- NOTES:  
 1. REFER TO SPECIFICATION 23 31 13 FOR ADDITIONAL REQUIREMENTS.  
 2. FACTORY INSTALLED ELECTRIC ACTUATOR.

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PROJECT ENGINEER:	C. THUNHORST		
DESIGNED BY:	T. NOLAN		
DRAWN BY:	P. GREER		
CHECKED BY:	D. WITTE		
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**Hazen**  
 HAZEN AND SAWYER  
 10619 SOUTH JORDAN GATEWAY,  
 SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
 SEWER IMPROVEMENT DISTRICT  
 OGDEN, UT  
 DEWATERING BUILDING HVAC  
 IMPROVEMENTS

HVAC  
 SCHEDULES

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H003

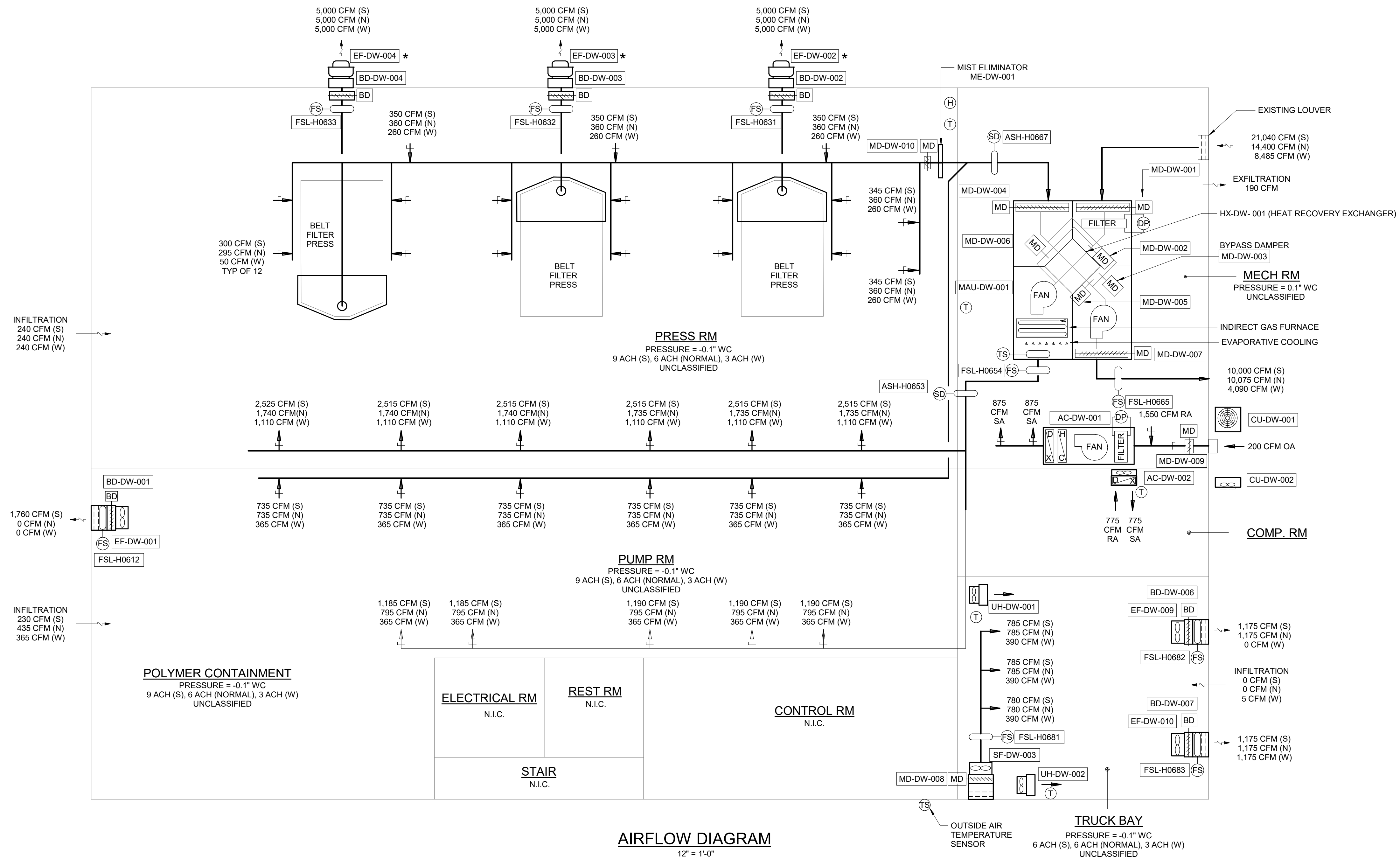


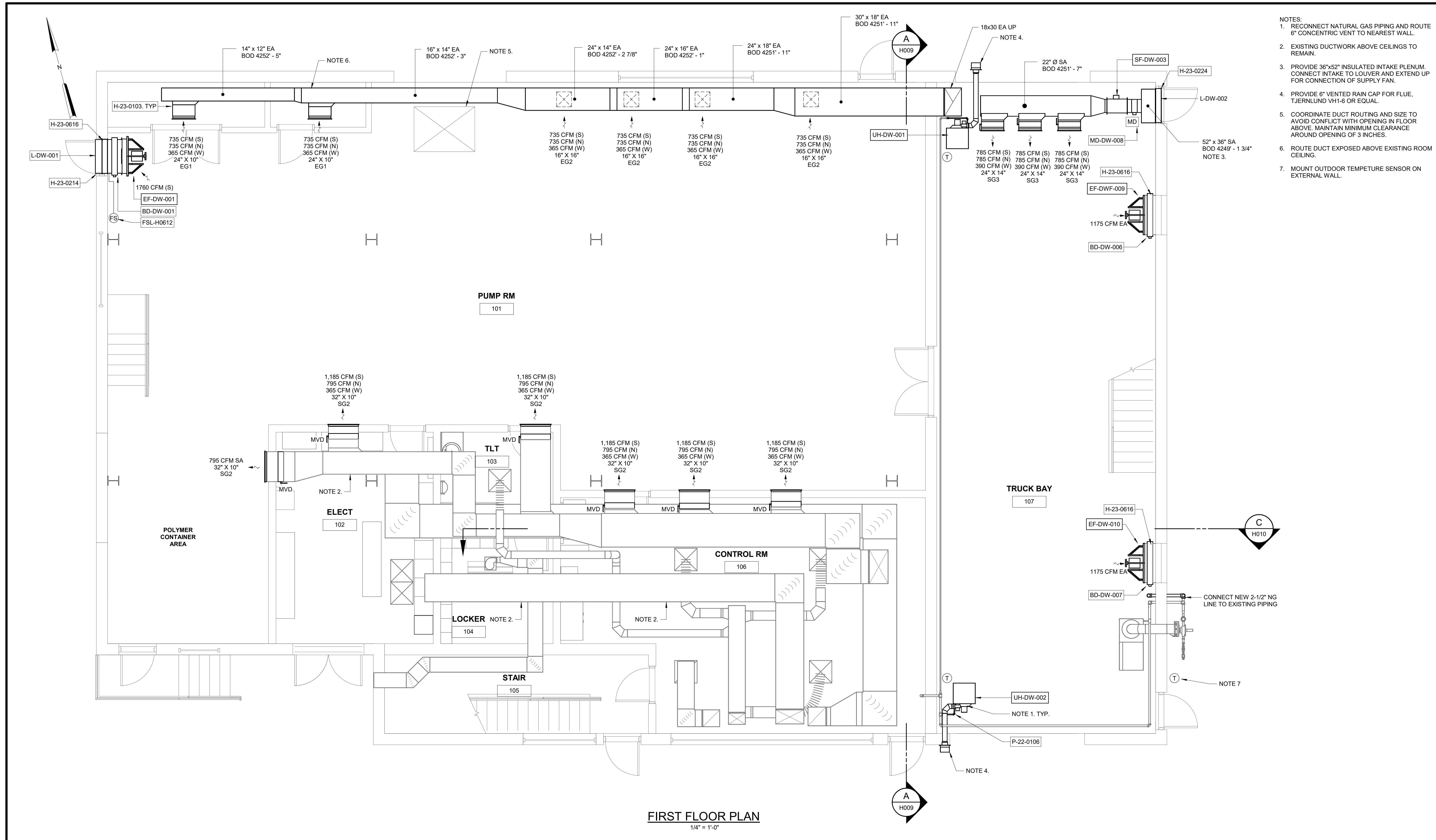
**DEWATERING AIRFLOW CONDITIONS**

	MAU-DW-1 SUPPLY (CFM)	MAU-DW-1 PRESS EXH (CFM)	MAU-DW-1 PUMP EXH (CFM)	EF-DW-002 EXHAUST (CFM)	EF-DW-003 EXHAUST (CFM)	EF-DW-004 EXHAUST (CFM)	EF-DW-001 EXHAUST (CFM)	PRESS ROOM SUPPLY (CFM)	PRESS ROOM EXHAUST (CFM)	PRESS ROOM INFILTRATION (+/- CFM)	PUMP ROOM SUPPLY (CFM)	PUMP ROOM EXHAUST (CFM)	PUMP ROOM INFILTRATION (+/- CFM)
SUMMER - ONE PRESS RUNNING	21,040	5,340	4,410	5,000	0	5000	1,760	15,100	15,340	-240	5,940	6,170	-230
SUMMER - TWO PRESSES RUNNING	21,040	5,340	4,410	5,000	5,000	0	1,760	15,100	15,340	-240	5,940	6,170	-230
SUMMER - THREE PRESSES RUNNING	21,040	340	4,410	5,000	5,000	5,000	1,760	15,100	15,340	-240	5,940	6,170	-230
NORMAL - ONE PRESS RUNNING	14,400	5,665	4,410	5,000	0	0	0	10,425	10,665	-240	3,975	4,410	-435
NORMAL - TWO PRESSES RUNNING	14,400	665	4,410	5,000	5,000	0	0	10,425	10,665	-240	3,975	4,410	-435
NORMAL - THREE PRESSES RUNNING	18,735	0	4,410	5,000	5,000	5,000	0	14,760	15,000	-240	3,975	4,410	-435
WINTER - ONE PRESS RUNNING	8,485	1,900	2,190	5,000	0	0	0	6,660	6,900	-240	1,825	2,190	-365
WINTER - TWO PRESSES RUNNING	11,585	0	2,190	5,000	5,000	0	0	9,760	10,000	-240	1,825	2,190	-365
WINTER - THREE PRESSES RUNNING	16,585	0	2,190	5,000	5,000	5,000	0	14,760	15,000	-240	1,825	2,190	-365

- NOTES:**
- NFPA 820 REQUIRES 6 AIR CHANGES PER HOUR TO REDUCE THE ELECTRICAL CLASSIFICATION TO UNCLASSIFIED. NORMAL OPERATION SHALL BE CONSIDERED 6 AIR CHANGES PER HOUR.
  - AIRFLOW RATES INDICATED WITH AN (S) INDICATOR ARE SUMMER MAXIMUM RATES. (N) INDICATES NORMAL OPERATION OF 6 AIR CHANGES PER HOUR. (W) INDICATES WINTER MINIMUM RATES OF 3 AIR CHANGES PER HOUR WHEN THE OUTSIDE AIR TEMPERATURES ARE BELOW 50° F AND THE SPACE IS NOT OCCUPIED.
  - ALL AIRFLOW RATES ARE DETERMINED WITH AT LEAST ONE PRESS EXHAUST FAN OPERATING. WHEN A PRESS IS NOT OPERATING IN SUMMER MONTHS THE SUPPLY AIR WILL BE REDUCED TO MAINTAIN A NEGATIVE PRESSURE.
  - \* indicates fan is operational when the associated press is running.
  - AIRFLOW VALUES ON SHOWN DIAGRAM ARE FOR ONE PRESSES RUNNING OPERATION. REFER TO AIRFLOW CONDITIONS FOR ADDITIONAL AIRFLOW MODES.

- NOTES:**
- CONTRACTOR SHALL BALANCE MAU, FANS, GRILLES, DIFFUSERS, AND ROOMS ACCORDING TO THE AIRFLOW CONDITIONS TABLE.
  - NOTE - THE EXHAUST FAN ASSOCIATED WITH EACH PRESS SHALL RUN WHEN THE ASSOCIATED PRESS IS RUNNING. THE AIR FLOW VALUES SHOWN IN THIS TABLE FOR EF-DW-002, EF-DW-003 AND EF-DW-004 REPRESENT THE NUMBER OF PRESS HOOD FANS RUNNING AND NOT THE ACTUAL FANS RUNNING.
  - THERE IS ONLY ONE SET OF EXHAUST FANS IN MAU-DW-1. MAU-DW-1 PRESS EXH AND MAU-DW-1 PUMP EXH REPRESENTS THE AIR SPLIT TO BE ACHIEVED BY MODULATING





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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE

BID SET



**Hazen**

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
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CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

DATE: OCTOBER 2024

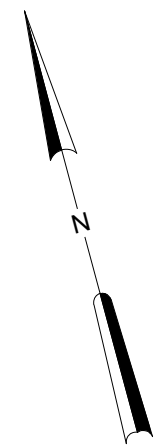
HAZEN NO.: 70123-000

CONTRACT NO.: 1

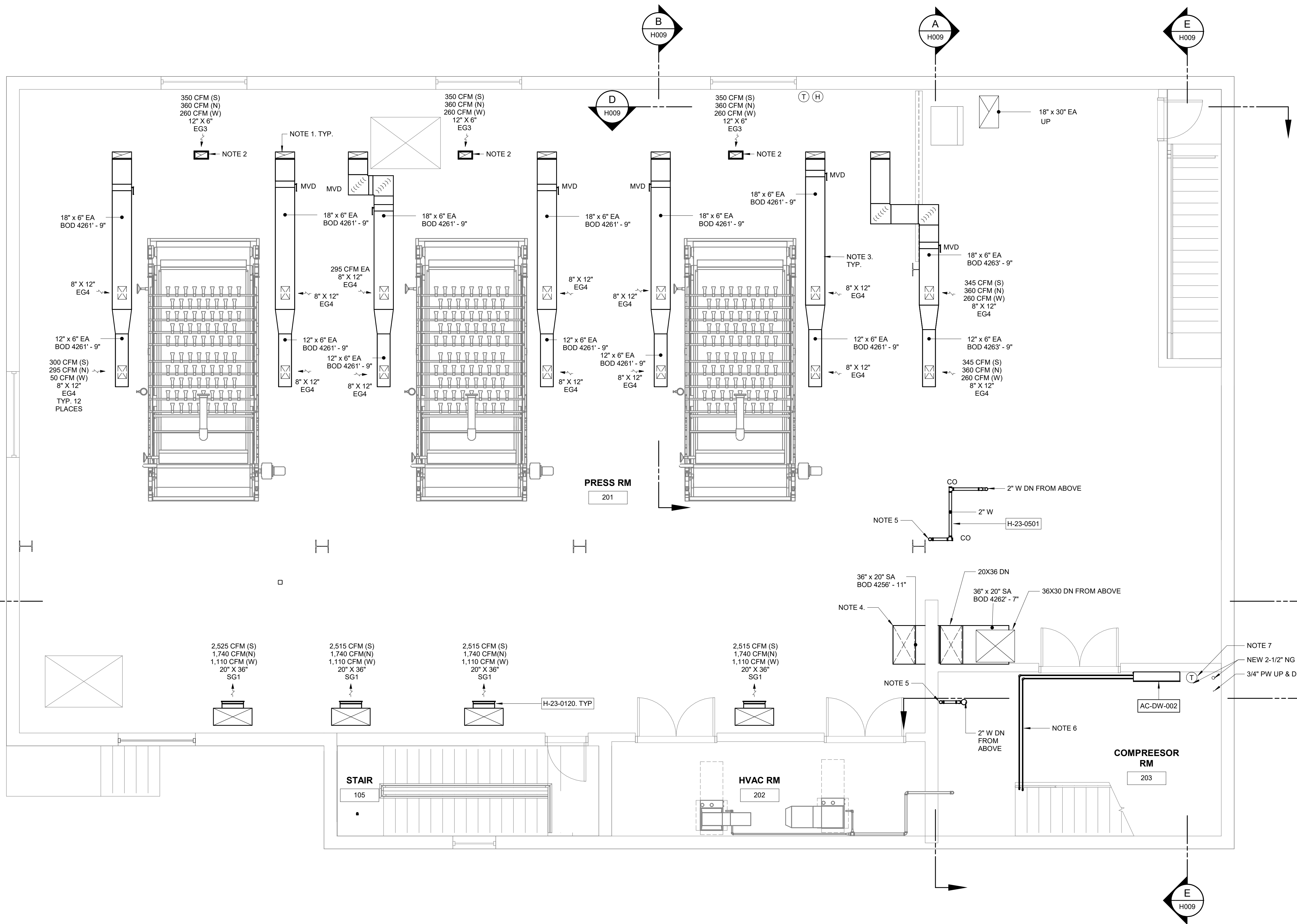
DRAWING NUMBER: H005

HVAC  
FIRST FLOOR PLAN





- NOTES:
1. DROP DUCT ALONG OUTSIDE OF STRUCTURE. COORDINATE ROUTING TO AVOID ACCESS, CONDUITS AND PIPING.
  2. DUCT TO TERMINATE 1'-6" ABOVE FINISHED FLOOR. COVER END OF DUCT WITH 1/2" STAINLESS STEEL WIRE MESH.
  3. MOUNT DUCT TIGHT TO BOTTOM OF STRUCTURAL STEEL TO MAINTAIN MAXIMUM CLEARANCE UNDER DUCT.
  4. CONNECT NEW SUPPLY DUCT TO EXISTING DUCT ABOVE FLOOR PENETRATION PRIOR TO DUCT DROPPING DN ABOVE CONTROL ROOM CEILING.
  5. DROP 2" WASTE DOWN THRU FLOOR. CONNECT TO EXISTING WASTE LINES BELOW. FIELD VERIFY LOCATIONS OF CONNECTION PRIOR TO CONSTRUCTION.
  6. ROUTE REFRIGERANT LINE SET PER MANUFACTURER'S RECOMMENDATIONS
  7. MOUNT THERMOSTATS 48" A.F.F. COORDINATE LOCATION WITH OWNER, DOOR SWINGS, AND WALL MOUNTED DEVICES.



SECOND FLOOR PLAN  
1/4" = 1'-0"

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PROJECT ENGINEER:	C. THUNHORST		
DESIGNED BY:	T. NOLAN		
DRAWN BY:	T. NOLAN		
CHECKED BY:	D. WITTE		
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"		
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**Hazen**

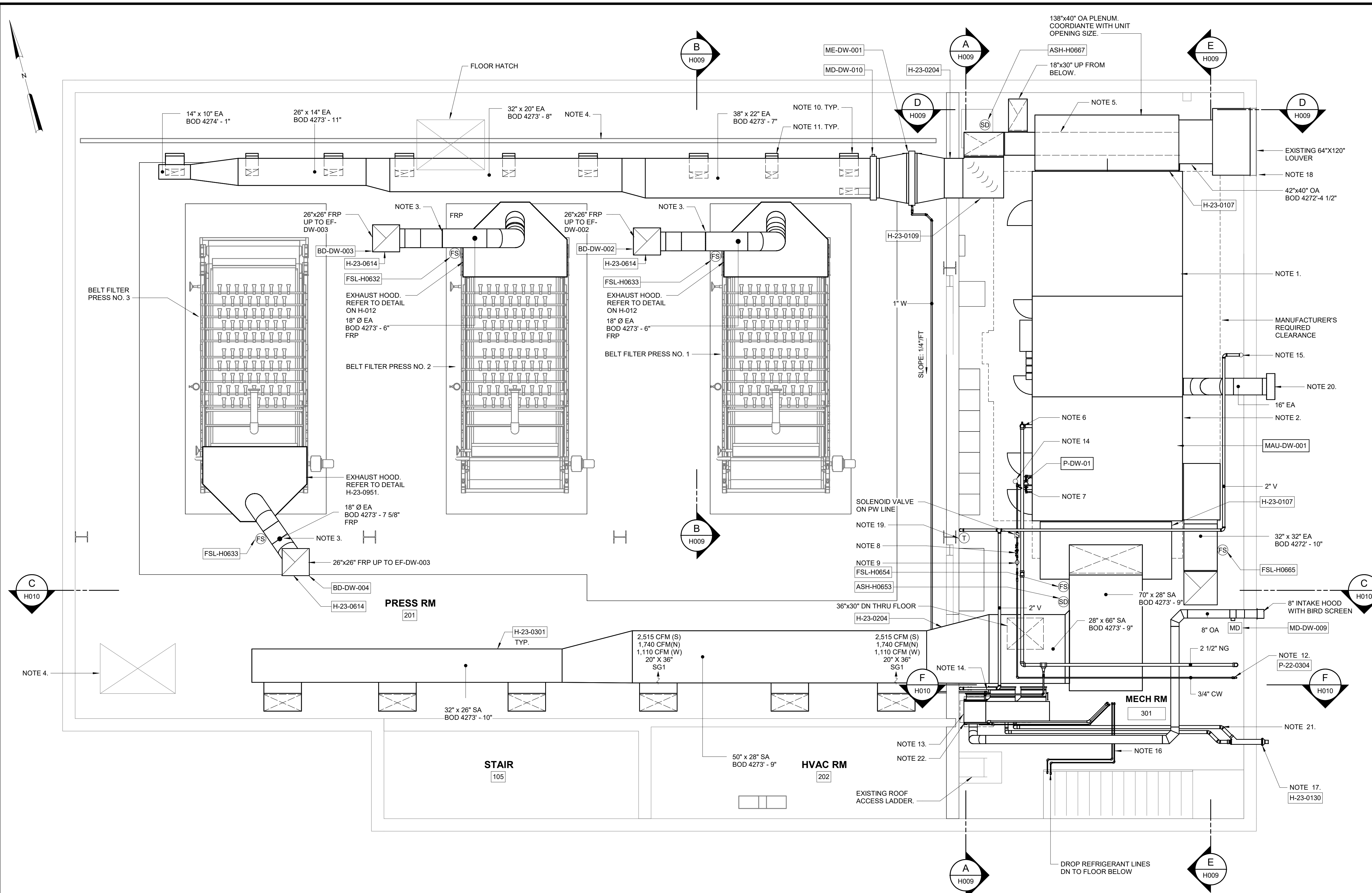
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SUITE 130, SOUTH JORDAN, UT 84095

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SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

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HVAC  
SECOND FLOOR LOWER PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H006



- NOTES:
- MAKE-UP AIR UNIT SHALL BE CONSTRUCTED OF MODULES TO BE LOWERED THRU THE EXISTING ROOF OPENING AND FASTENED TOGETHER IN PLACE. FIELD VERIFY OPENING DIMENSIONS PRIOR TO OBTAINING UNIT.
  - EXTEND EXISTING HOUSEKEEPING PAD TO SET NEW MAKE-UP AIR UNIT ON PAD TO EXTEND 6' BEYOND UNIT ON ALL SIDES. FIELD VERIFY DIMENSIONS WITH SUPPLIED EQUIPMENT.
  - PROVIDE FLANGED JOINT FOR DUCT REMOVAL. COORDINATE FSL LOCATIONS WITH JOINT SO THAT THE FSL REMAINS DURING MAINTENANCE.
  - COORDINATE DUCT LAYOUT TO AVOID INTERFERENCE WITH CRANE RAIL AND HOIST ASSEMBLY OPERATION.
  - COMBINE UPPER EXHAUST DUCT AND PUMP ROOM EXHAUST DUCT AND CONNECT TO RETURN OPENING OF UNIT.
  - 2" NG GAS CONNECTION WITH SHUTOFF VALVE AND DRIP LEG.
  - 3/4" PW CONNECTION WITH SHUTOFF VALVE.
  - INSTALL A 3/4" REDUCED PRESSURE BACKFLOW PREVENTER IN POTABLE WATER LINE FEEDING EVAPORATIVE COOLER. REFER TO DETAIL P-22-0303.
  - INSTALL A 3/4" PRESSURE REGULATOR IN POTABLE WATER LINE FEEDING EVAPORATIVE COOLER. SET TO 30 PSIG (ADJ.)
  - 18"x6" DUCT TAKE-OFF FROM BOTTOM OF DUCT. OFFSET TO DROP ALONG OUTSIDE OF HANDRAIL AND STRUCTURE.
  - 12"x6" DUCT TAKE-OFF FROM BOTTOM OF DUCT. OFFSET TO DROP ALONG OUTSIDE OF HANDRAIL AND STRUCTURE.
  - INSTALL NEW HOSE BIBB WITH INTEGRAL VACUUM BREAKER 24" ABOVE FINISHED FLOOR. ZURN Z1341-RC OR EQUAL.
  - MOUNT AIR HANDLING UNIT ON WELDED STRUCTURAL ANGLE SUPPORT FRAME. REFER TO DETAIL H-23-0950. PROVIDE 22"x28"x16" DEEP INSULATED PLENUM CONNECTED TO RETURN OPENING OF UNIT. PROVIDE (2) RG1 RETURN GRILLE ON FACE OF PLENUM. TAP OUTSIDE AIR DUCT INTO PLENUM.
  - PROVIDE NEW 4" HUB DRAIN IN FLOOR WITH 2" WASTE OULET. COORDINATE LOCATION WITH EQUIPMENT PLACEMENT. REFER TO DETAIL P-22-0220.
  - CONNECT 2" VENT TO EXISTING 4" VENT RISER. FIELD VERIFY LOCATION.
  - ROUTE REFRIGERANT LINE SET PER MANUFACTURER'S RECOMMENDATIONS.
  - INSTALL CONCENTRIC VENT PER MAUFACTURER'S RECOMMENDATIONS.
  - OUTSIDE AIR INTAKES SHALL BE A MIN. OF 10'-0" FROM PLUMBING VENTS, EXHAUST FAN DISCHARGES AND FLUE TERMINATIONS. CONTRACTOR SHALL FIELD VERIFY DIMENSIONS PRIOR TO INSTALLATION.
  - MOUNT THERMOSTATS 48" A.F.F. COORDINATE LOCATION WITH OWNER, DOOR SWINGS, AND WALL MOUNTED DEVICES.
  - FURNISH AND INSTALL 10" CLASS "B" VENT THRU WALL TO VENT CAP. PROVIDE FLASHING CONE, STORM COLLAR AND FLASH WALL PENETRATION WEATHER TIGHT. MAINTAIN RECOMMENDED CLEARANCES FROM COMBUSTIBLES.
  - FURNISH AND INSTALL 3" PVC VENT AND COMBUSTION AIR PIPING TO CONCENTRIC VENT KIT THRU WALL. INSTALL PIPING AND CONCENTRIC VENT PER MANUFACTURER'S RECOMMENDATIONS.
  - FURNISH AND INSTALL 3/4" MCD TO NEAREST HUB DRAIN OR FLOOR DRAIN. INSULATE MCD PIPING FROM UNIT TO OUTLET AS SPECIFIED.

SECOND FLOOR UPPER PLAN / THIRD FLOOR PLAN

1/4" = 1'-0"

1	BID SET	10/2024	CNT
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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE
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BID SET



**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

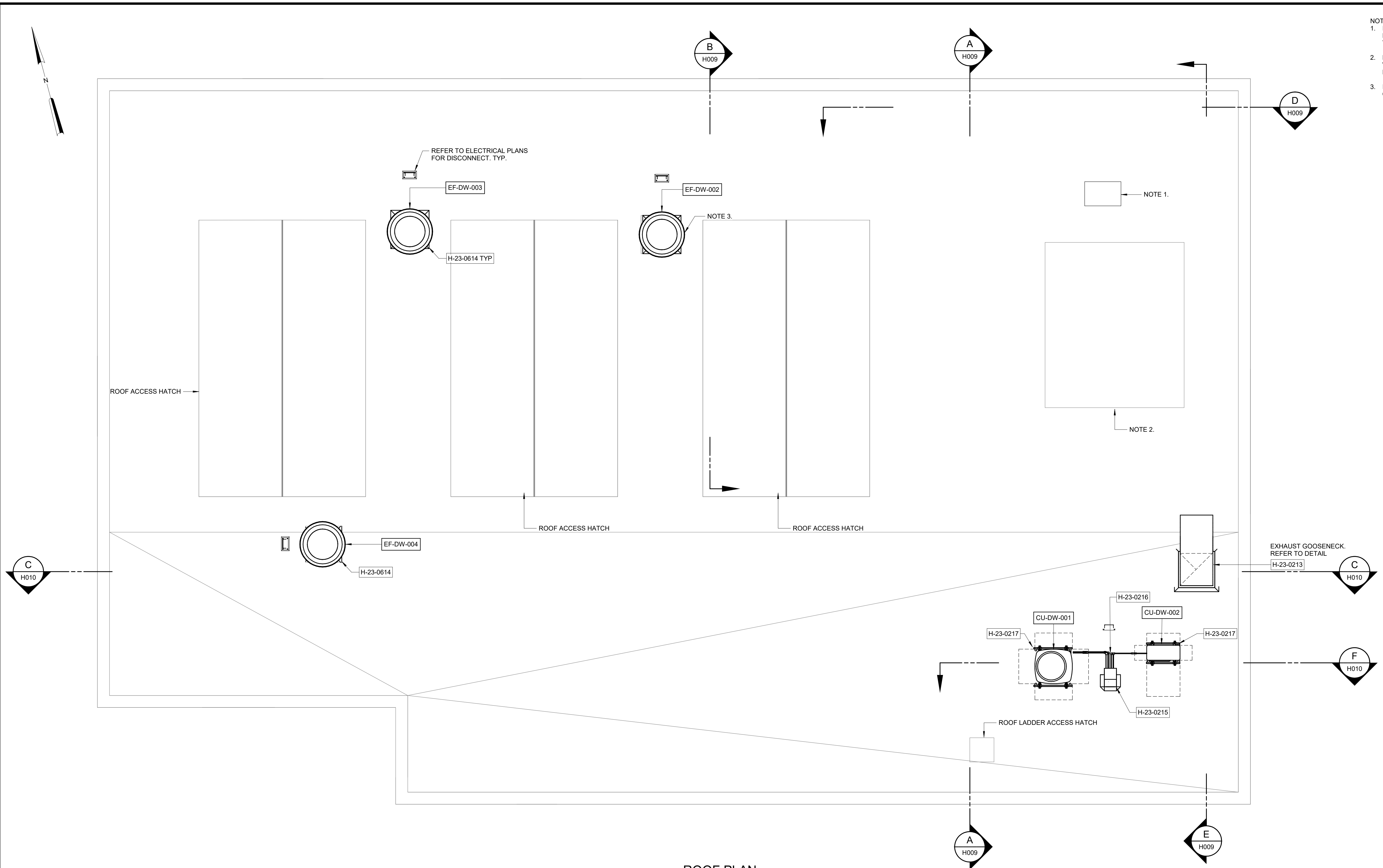
HVAC  
SECOND FLOOR UPPER PLAN / THIRD FLOOR PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H007

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- NOTES:
1. INSTALL INSULATED CURB CAP ON EXISTING ROOF CURB. FIELD VERIFY DIMENSIONS. REFER TO DETAIL H-23-0210.
  2. REPLACE EXISTING ROOF HATCH COVER. FIELD VERIFY DIMENSIONS. REFER TO STRUCTURAL PLANS FOR DETAILS.
  3. INSTALL NEW EXHAUST FAN ON EXISTING ROOF CURB. PROVIDE CURB ADAPTER AS NEEDED.



**ROOF PLAN**  
1/4" = 1'-0"

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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE

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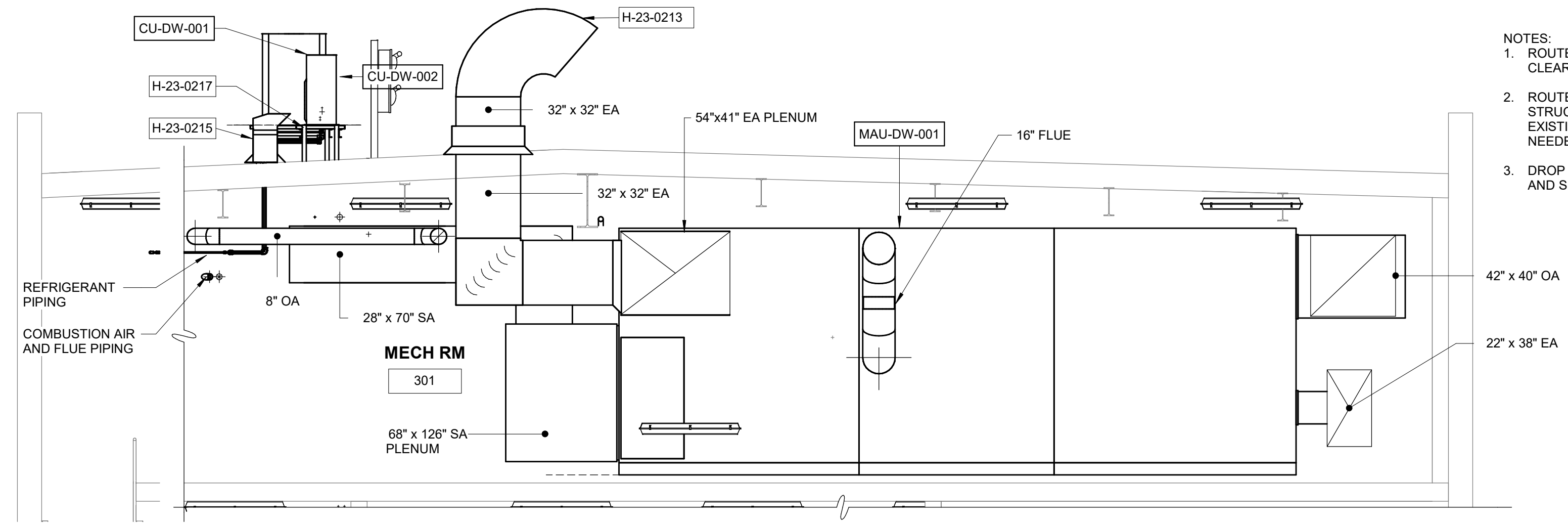
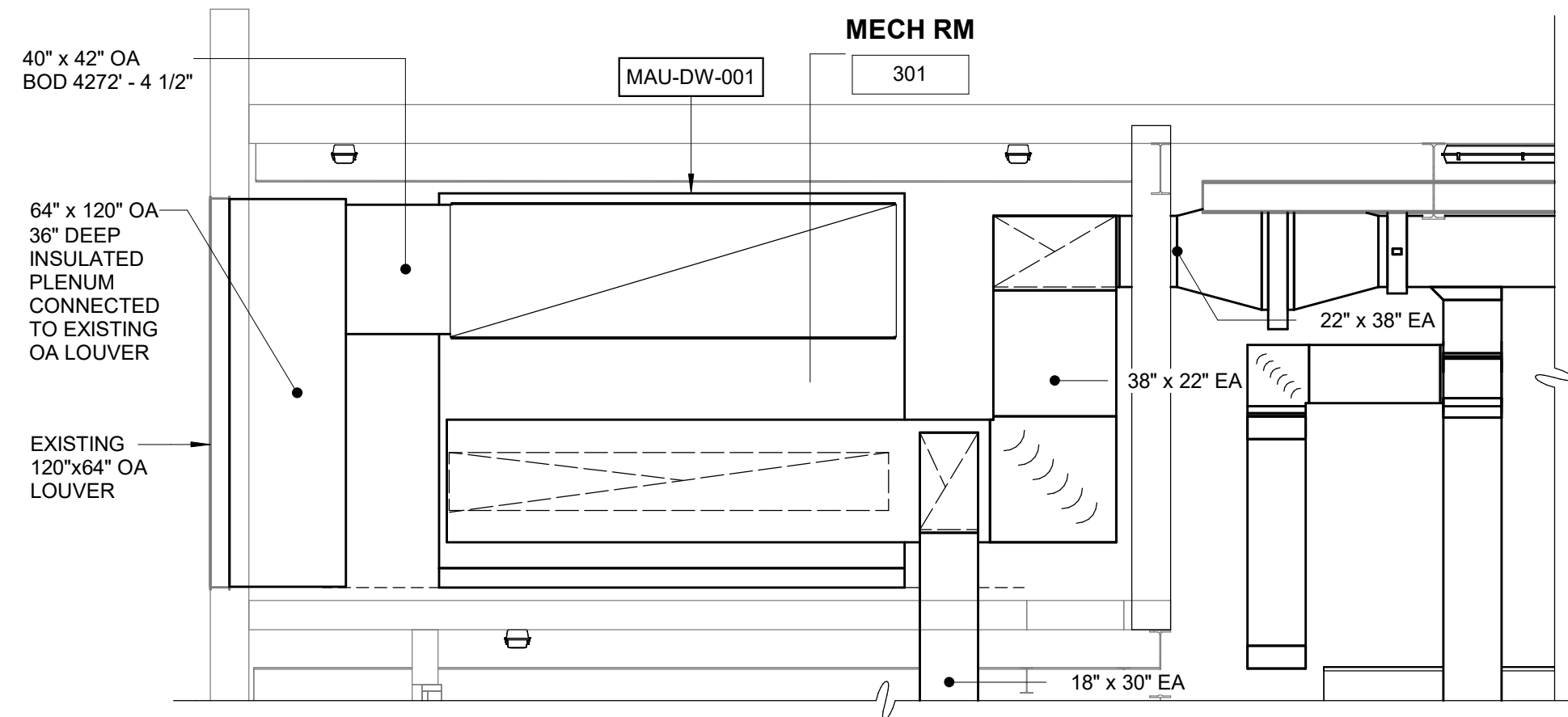
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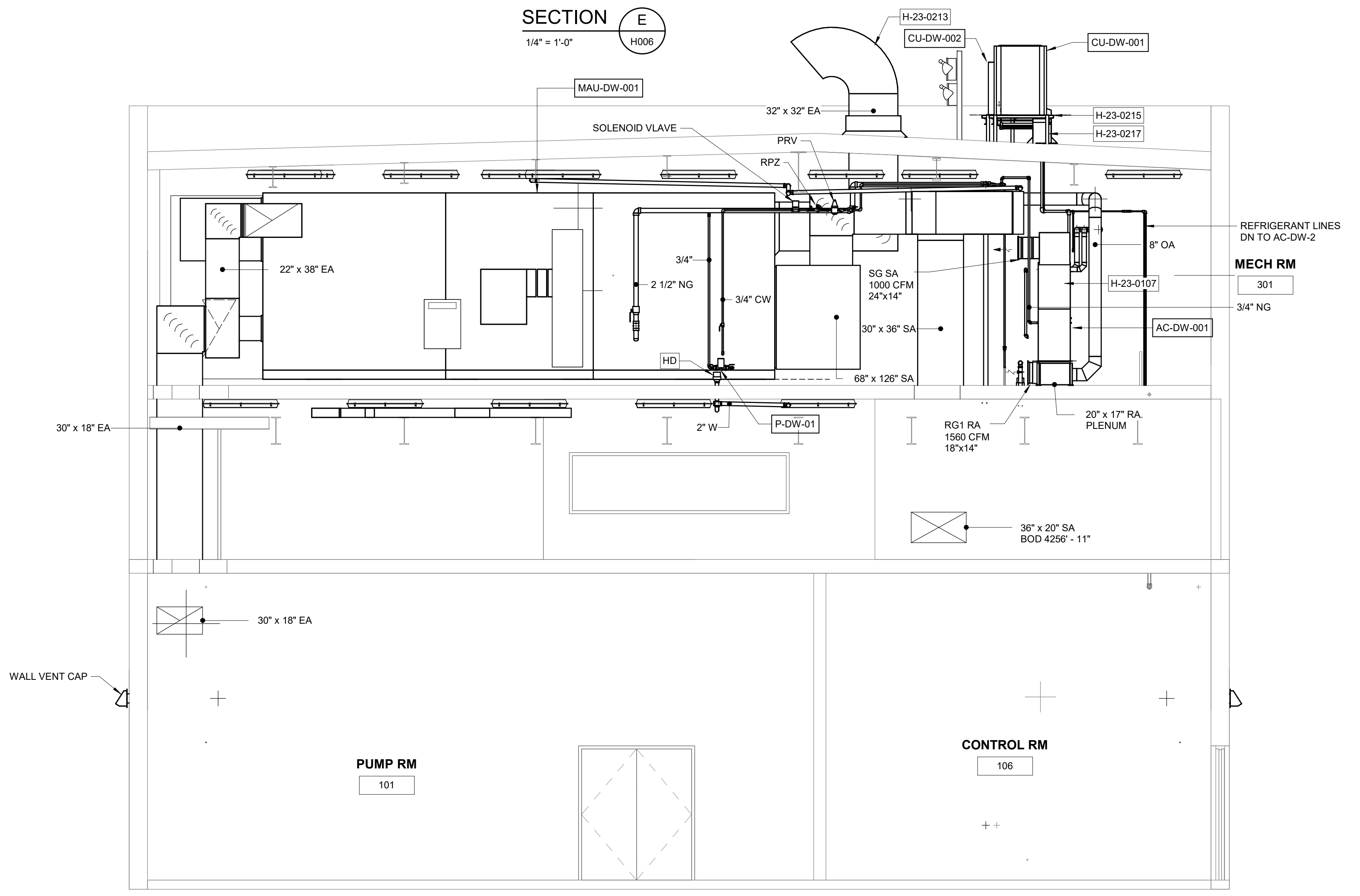
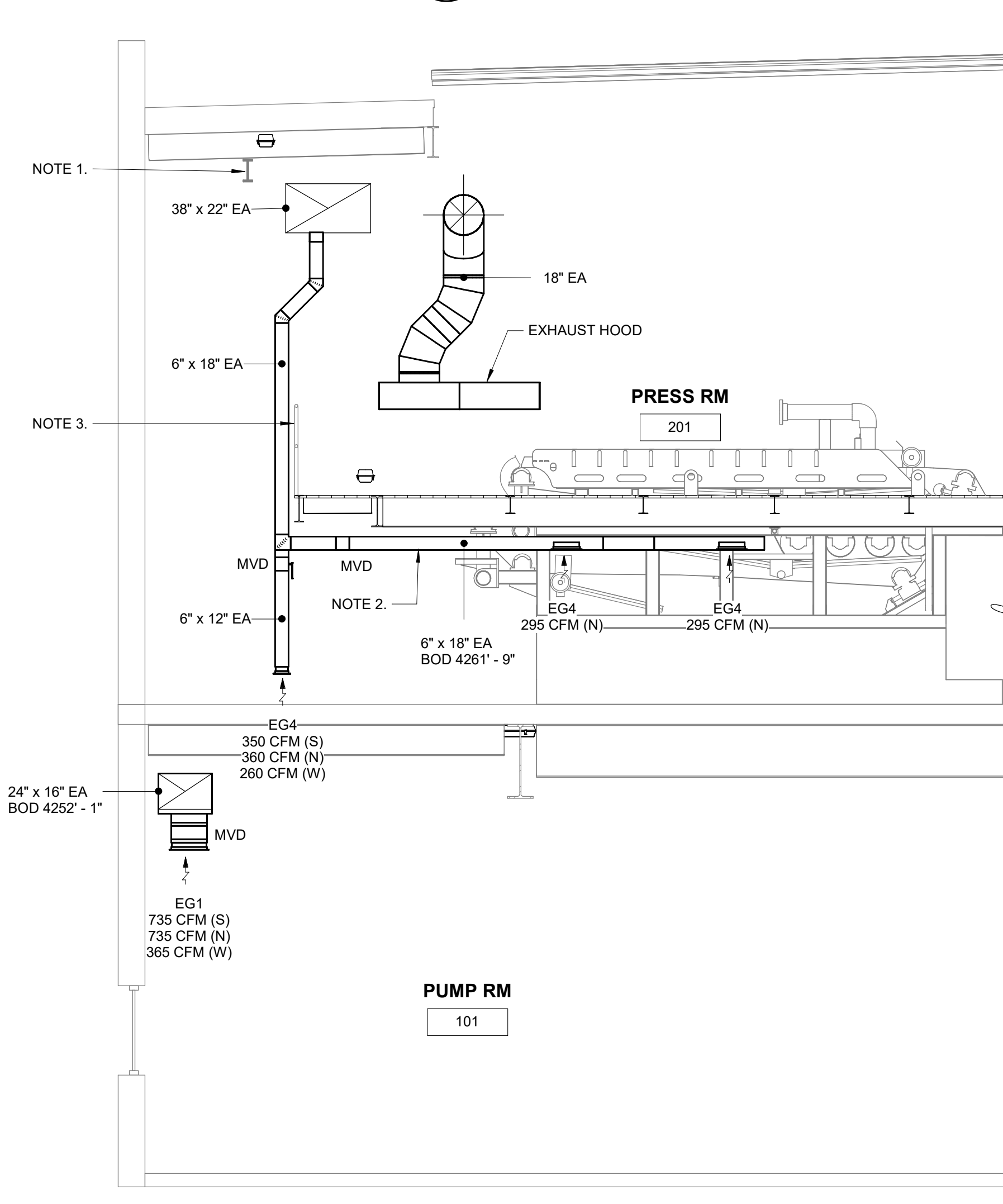
HVAC  
ROOF PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H008





- NOTES:
- ROUTE DUCT TO AVOID CRANE RAIL AND HOIST CLEARANCES.
  - ROUTE DUCT TIGHT TO WALKWAY SUPPORT STRUCTURE. FIELD VERIFY OBSTRUCTION OF EXISTING PIPING AND CONDUITS AND ADJUST AS NEEDED TO AVOID CONFLICTS.
  - DROP DUCT OUTSIDE OF WALKWAY HANDRAIL AND SUPPORT DUCT FROM STRUCTURE.



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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
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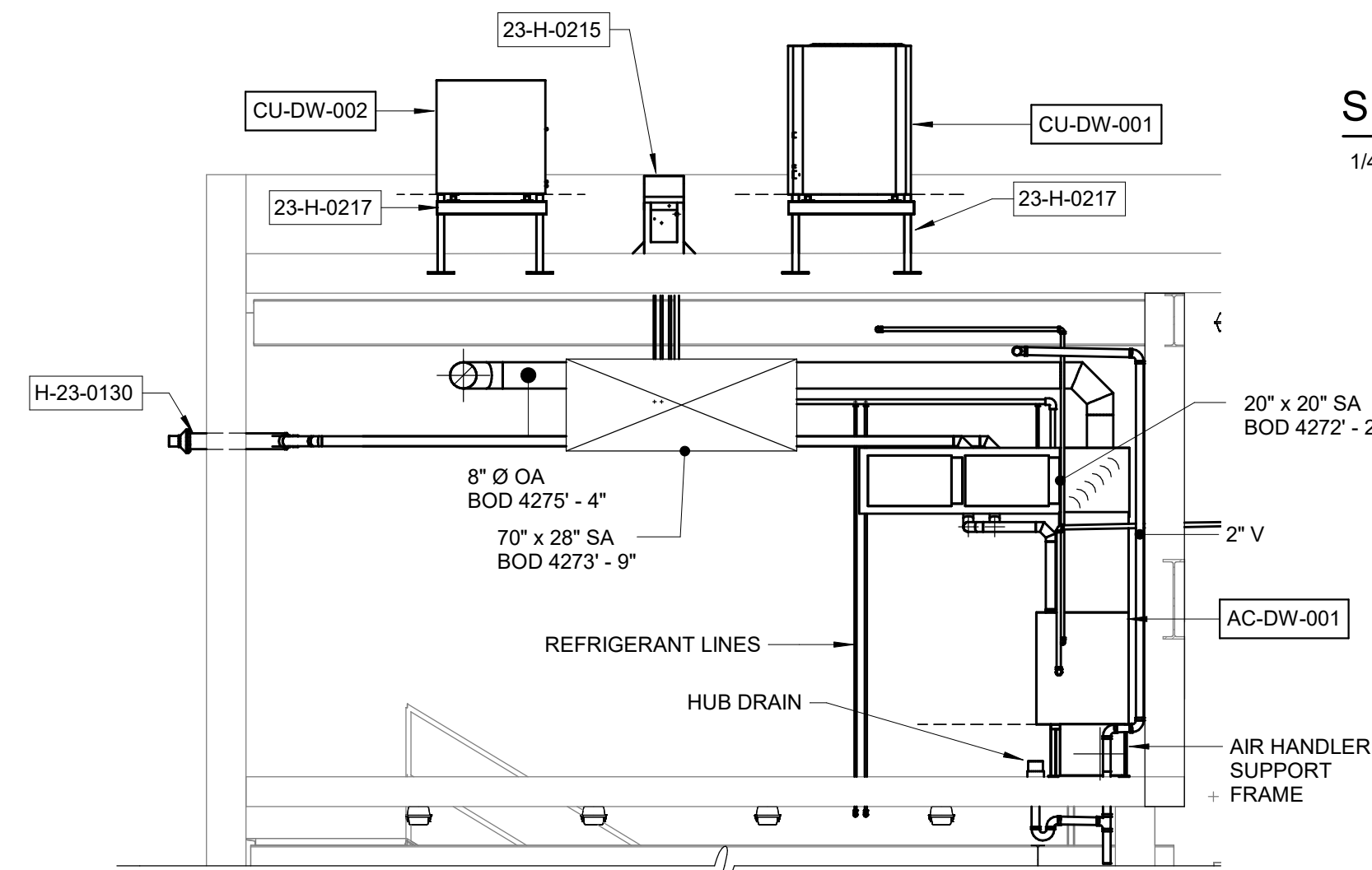
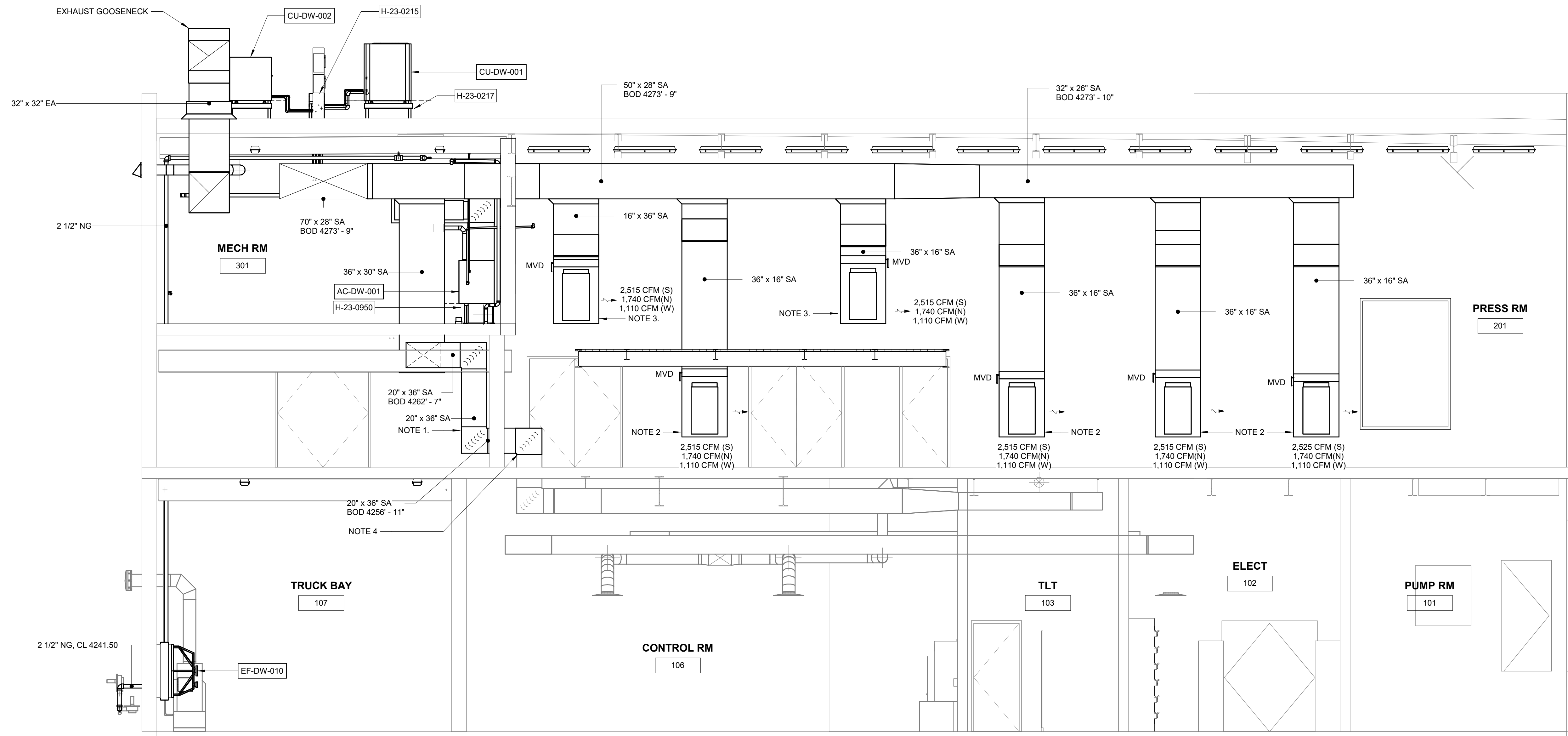
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IMPROVEMENTS

HVAC  
SECTIONS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H009

- NOTES:
1. OFFSET DUCT AND HOLD DUCT TIGHT TO WALL.
  2. TERMINATE DUCT AT ELEVATION 4258.0'.
  3. TERMINATE DUCT AT ELEVATION 4265.5' TO AVOID CEILING OF ROOM.
  4. CONNECT TO EXISTING DUCT. FIELD VERIFY LOCATION AND SIZE.



SECTION C  
1/4" = 1'-0" H005



SECTION F  
1/4" = 1'-0" H006

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PROJECT ENGINEER: C. THUNHORST  
 DESIGNED BY: T. NOLAN  
 DRAWN BY: P. GREER  
 CHECKED BY: D. WITTE

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0 1/2" 1"

BID SET



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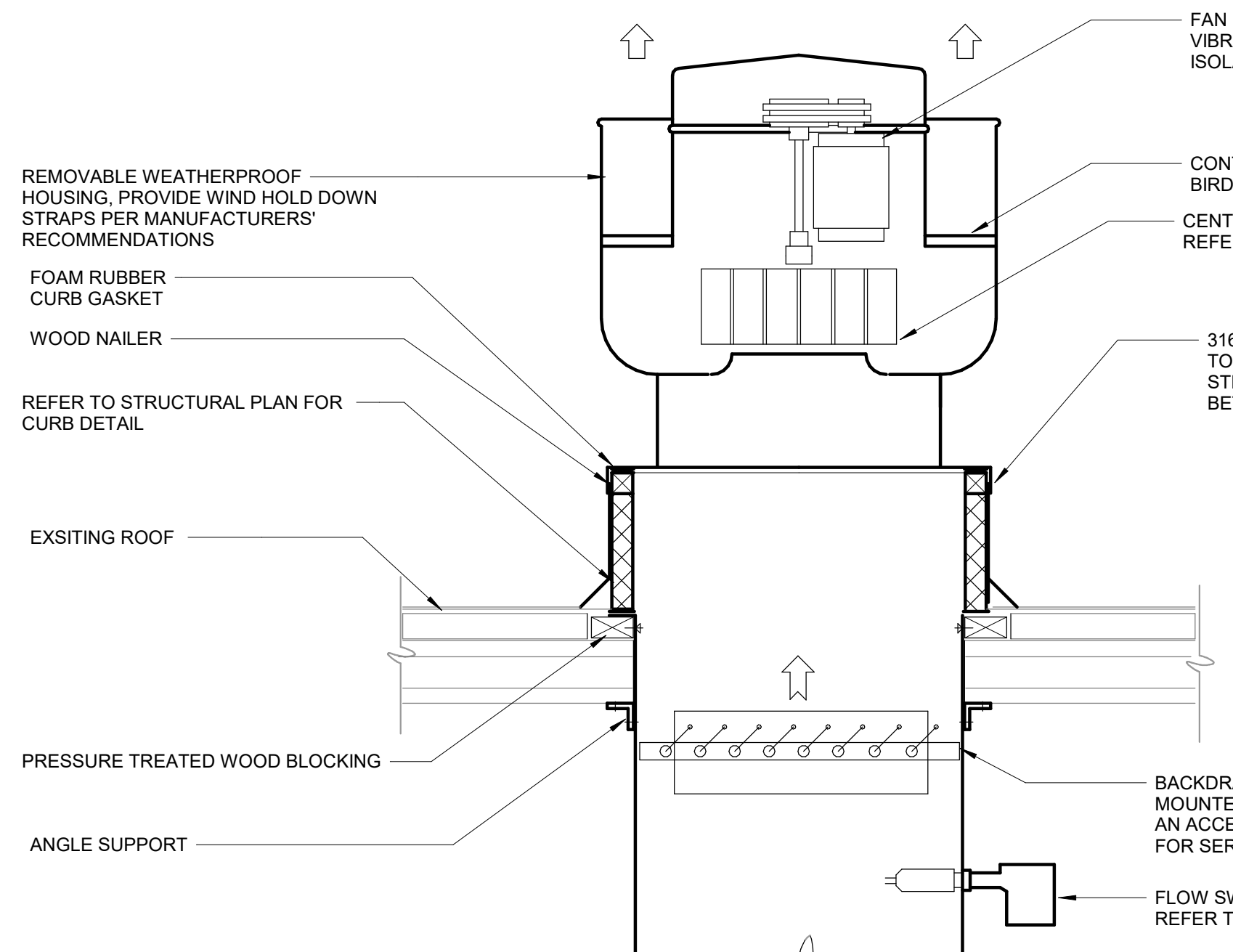
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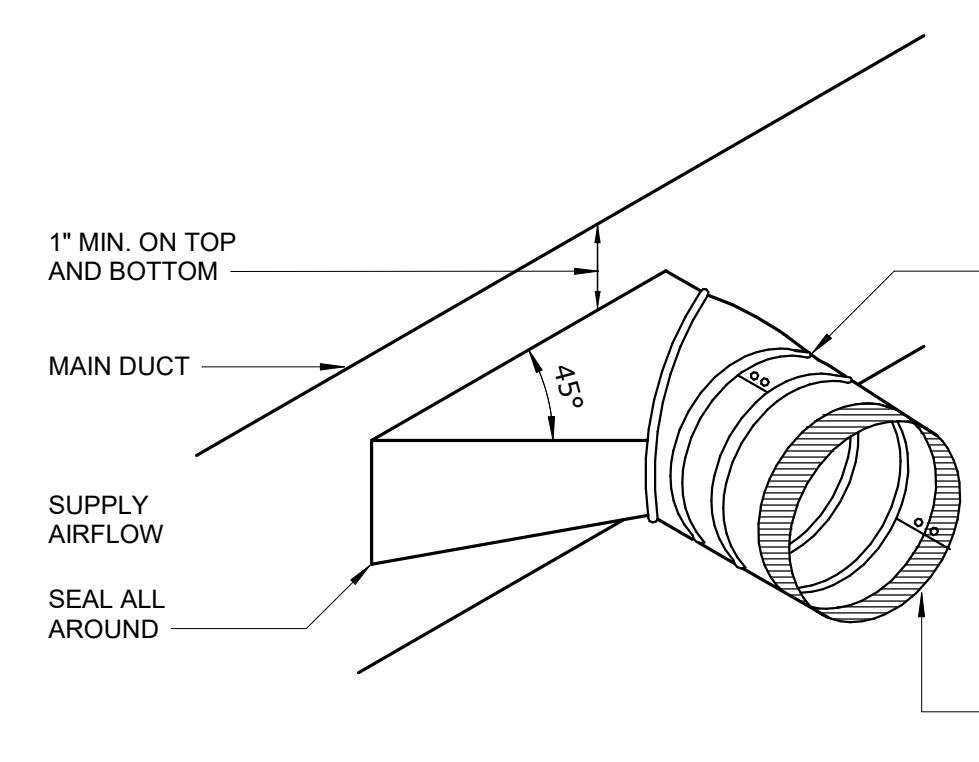
HVAC  
 SECTIONS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H010

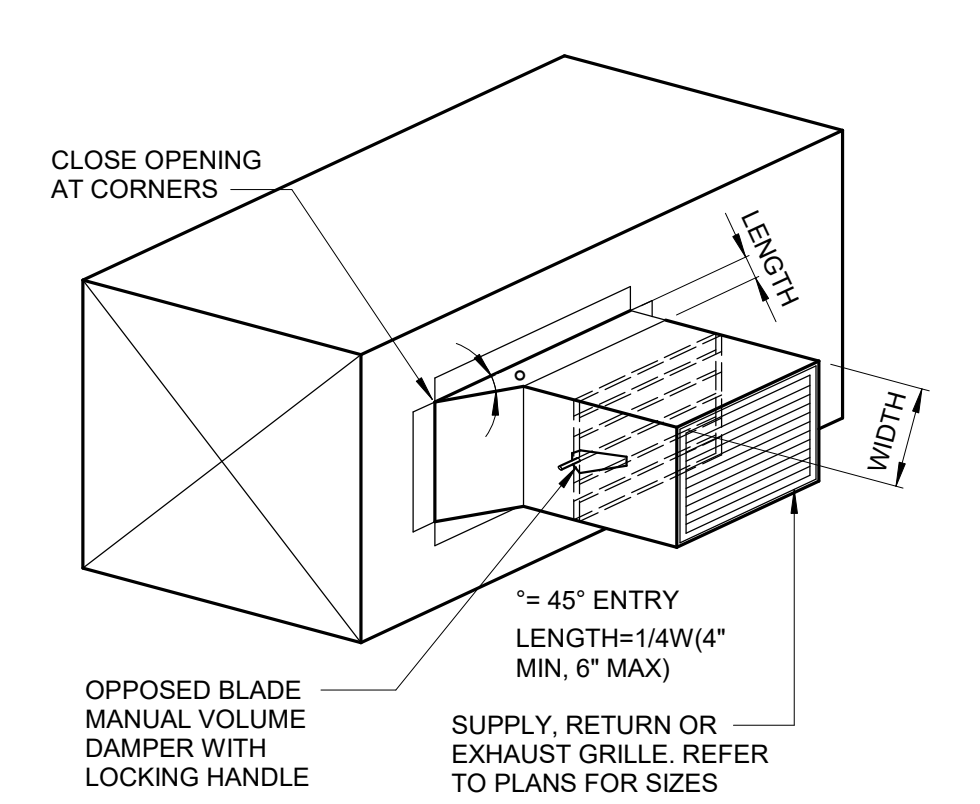




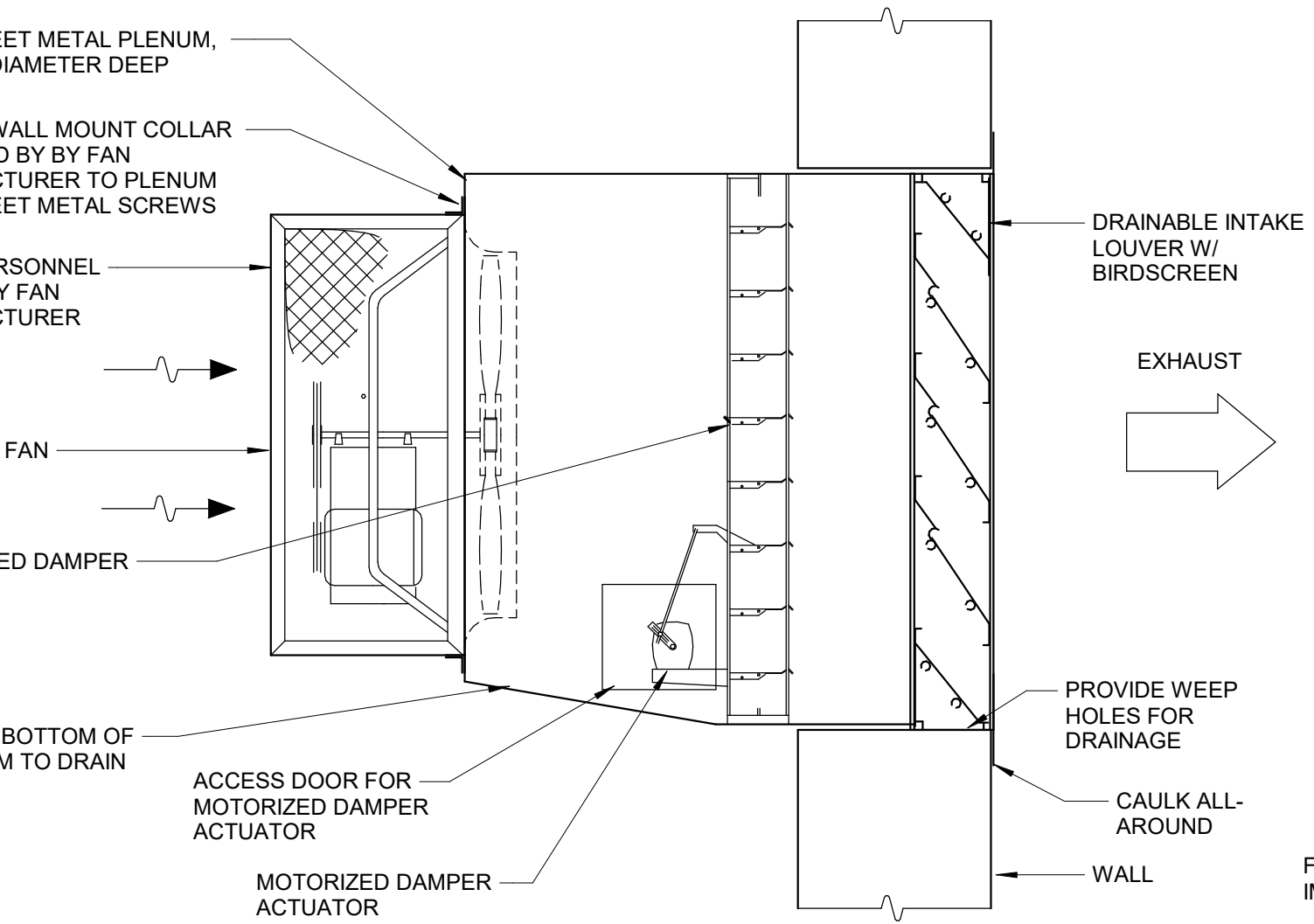
EXHAUST FAN  
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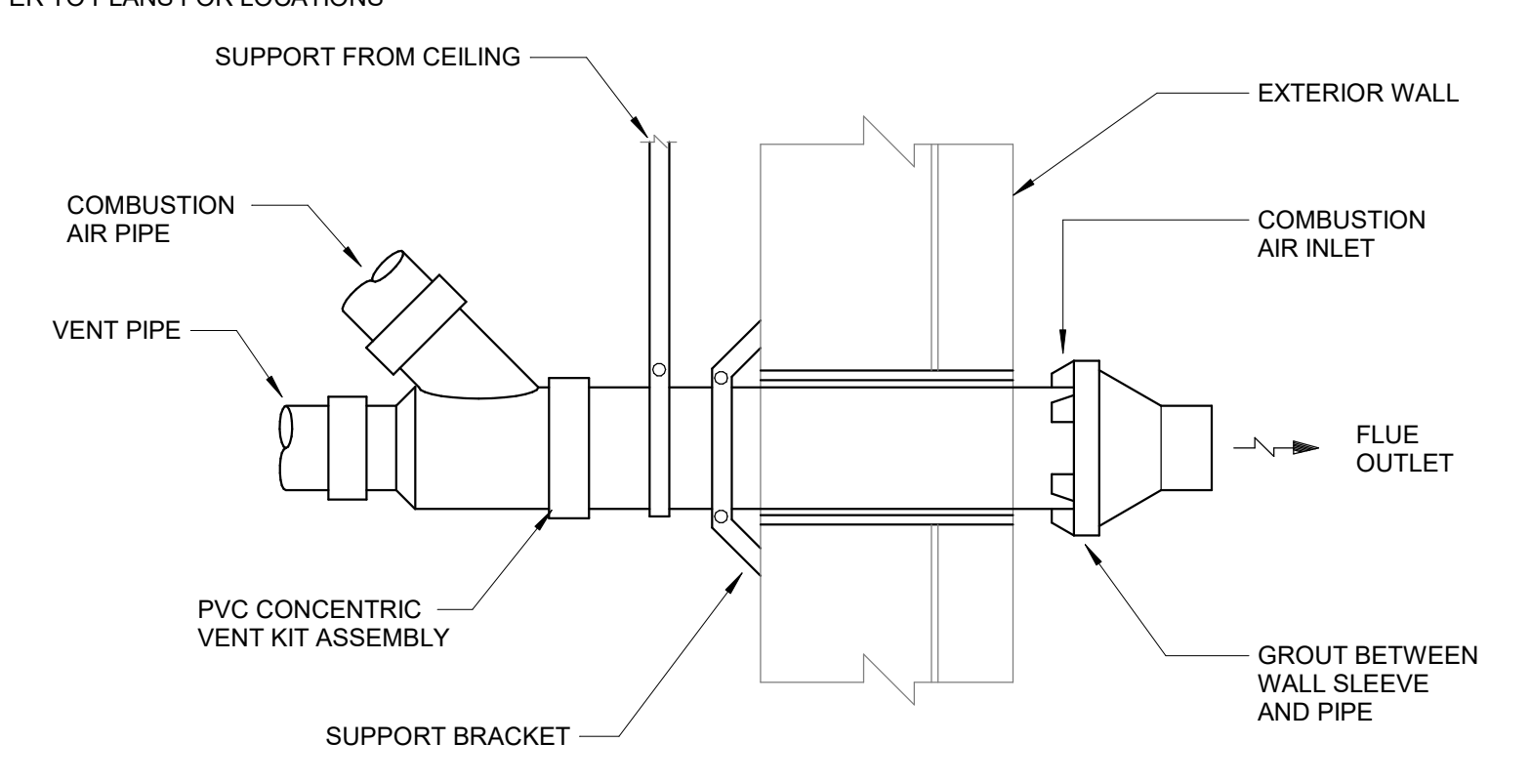
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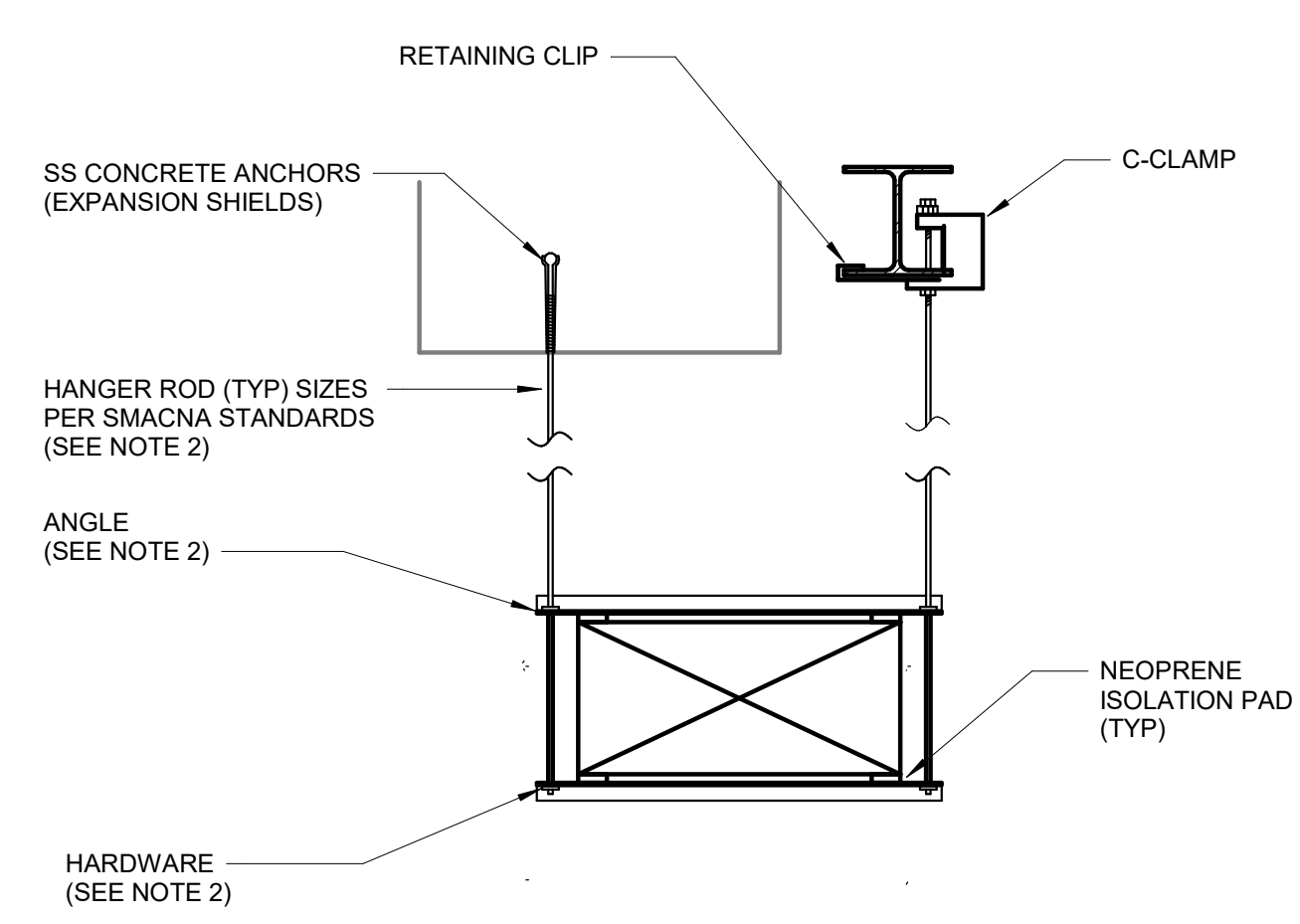
DUCT MOUNTED GRILLE  
H-23-0120



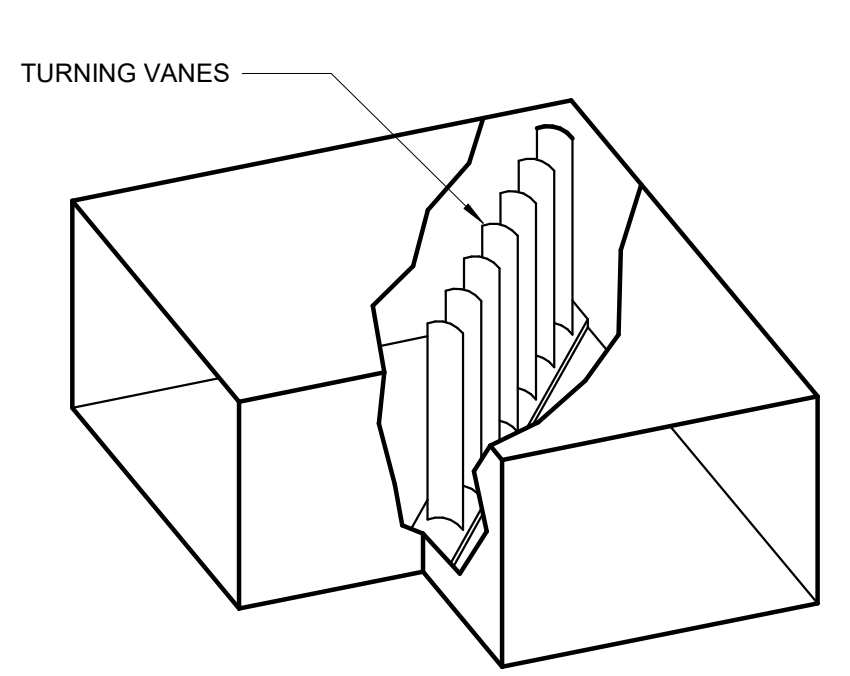
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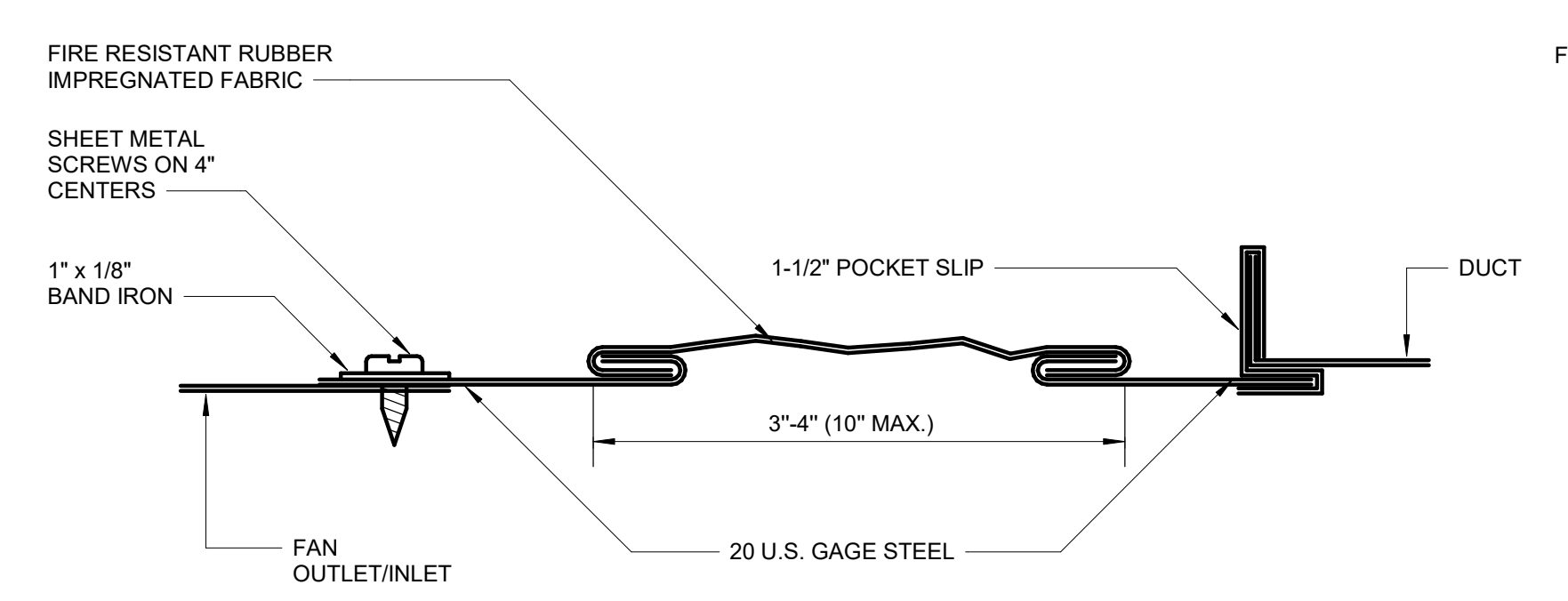
CONCENTRIC VENT  
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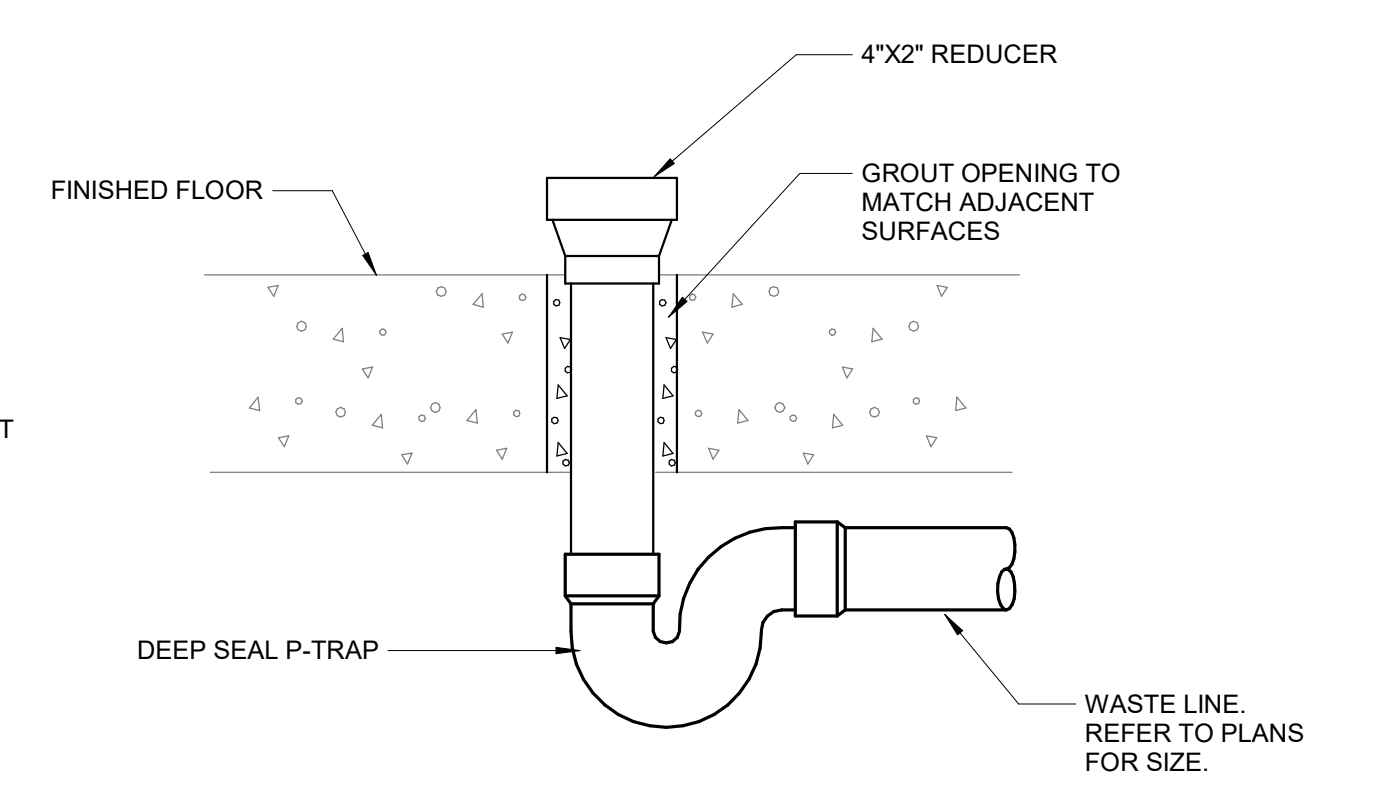
DUCT HANGING  
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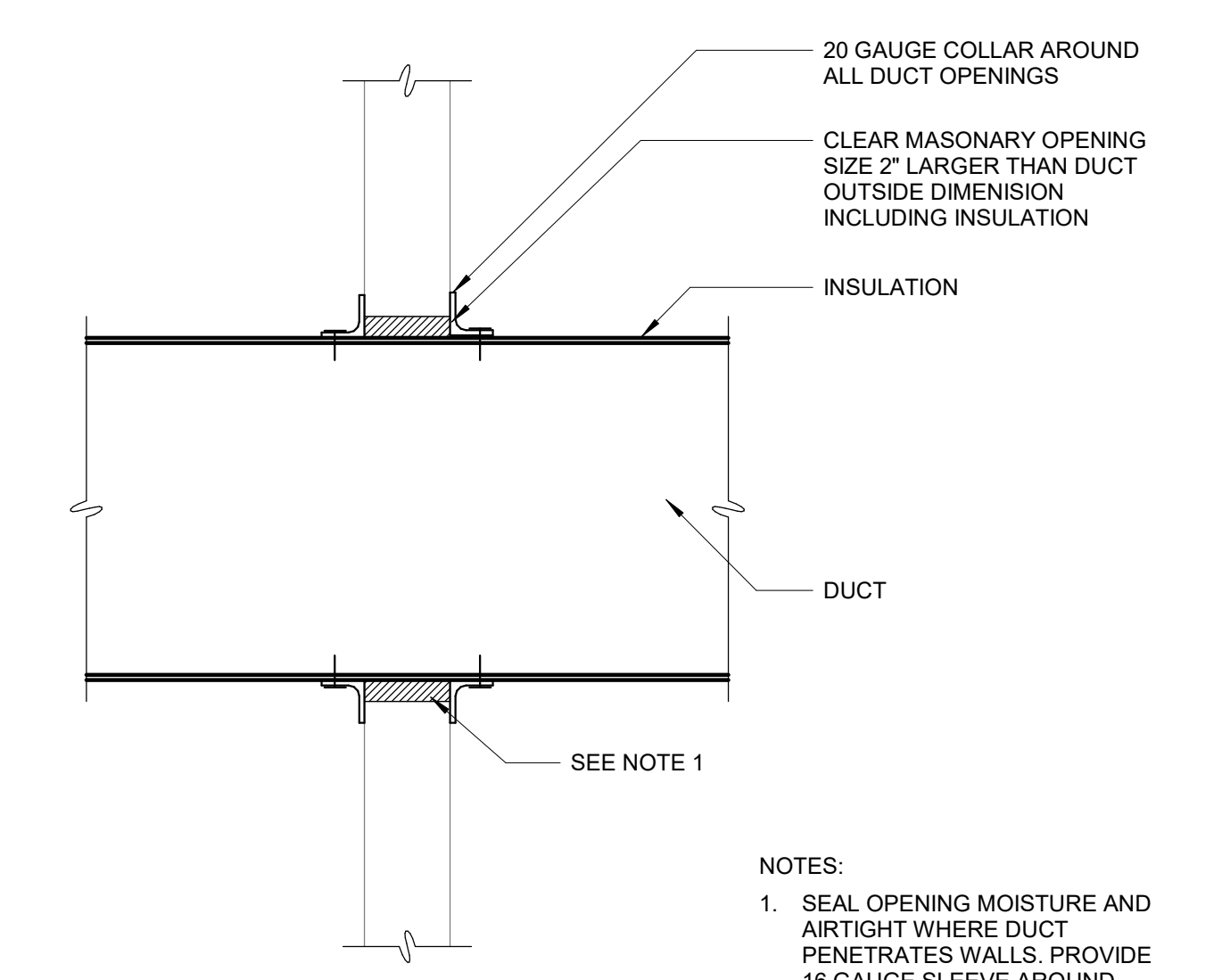
MITERED ELBOW  
H-23-0109



TYPICAL FLEXIBLE CONNECTION  
H-23-0107



HUB DRAIN  
P-22-0220



DUCT PENETRATION WALL  
H-23-0204

- NOTES:
- SEAL OPENING MOISTURE AND AIRTIGHT WHERE DUCT PENETRATES WALLS. PROVIDE 16 GAUGE SLEEVE AROUND ENTIRE OPENING.
  - SUPPORT MATERIALS SHALL MATCH DUCT MATERIALS.

- NOTES:
- SEAL OPENING MOISTURE AND AIRTIGHT WHERE DUCT PENETRATES WALLS. PROVIDE 16 GAUGE SLEEVE AROUND ENTIRE OPENING.

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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

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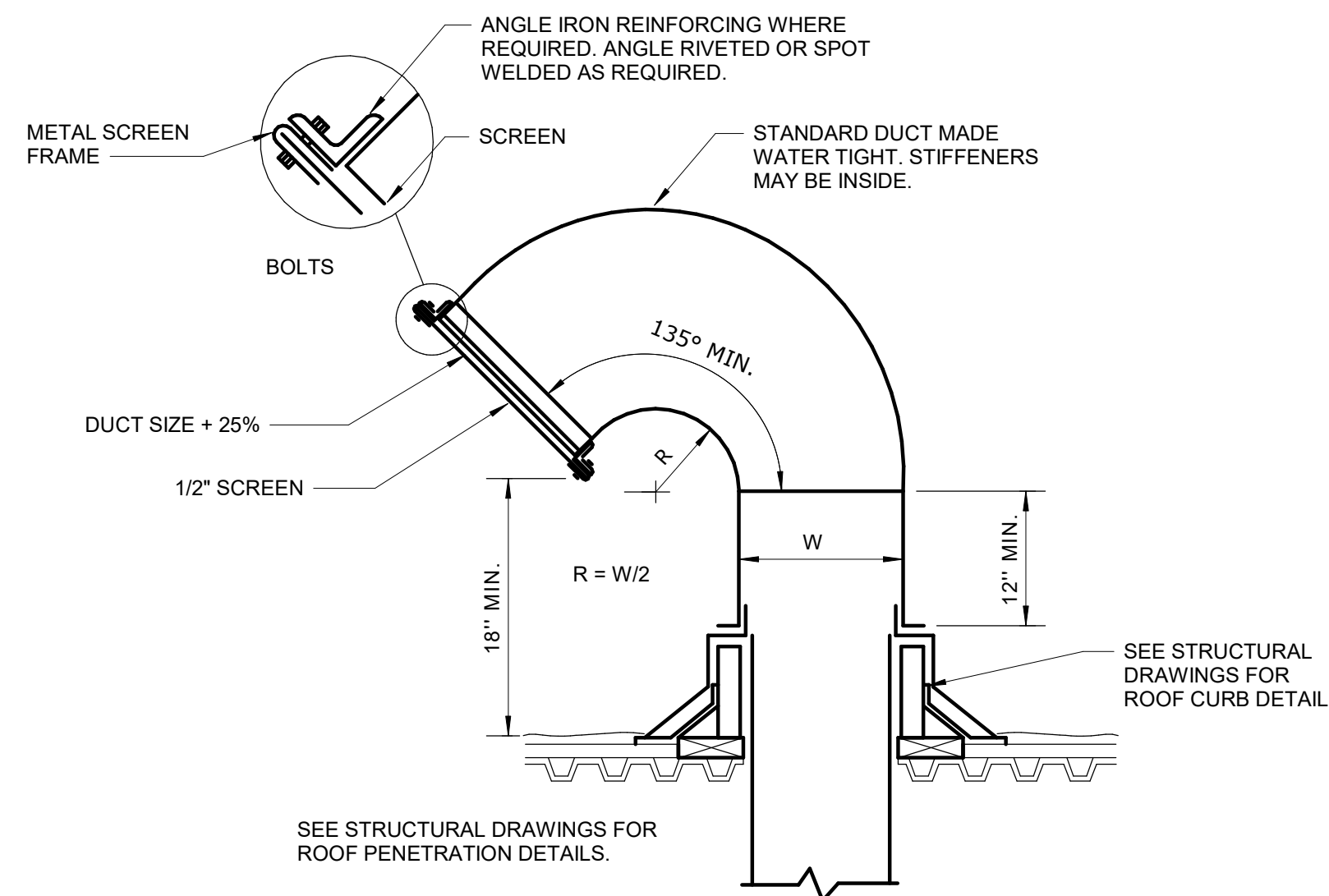


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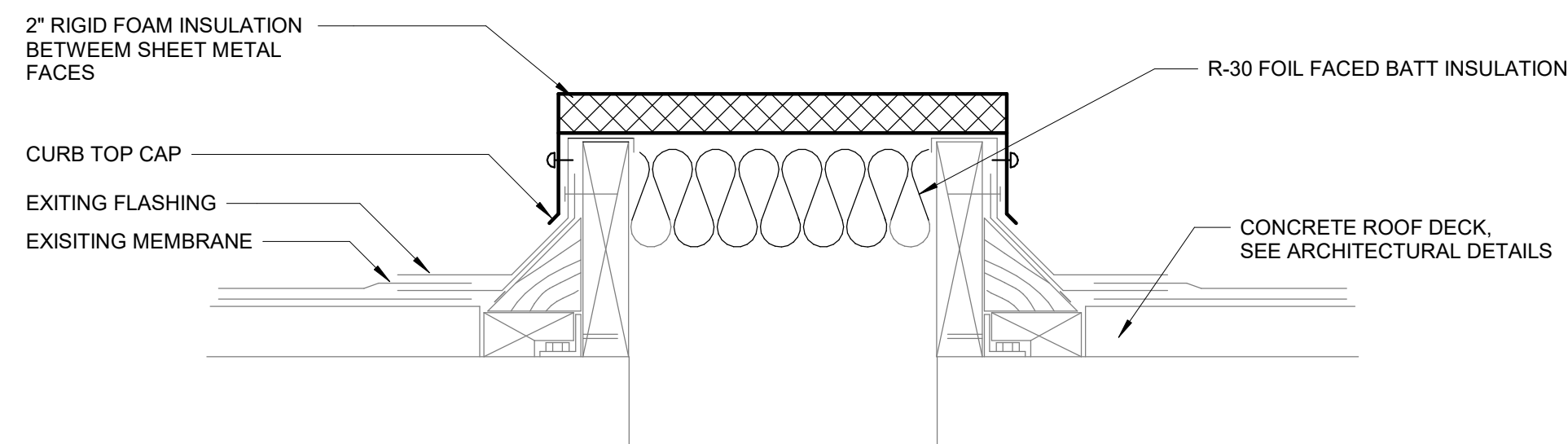
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HVAC  
DETAILS 1

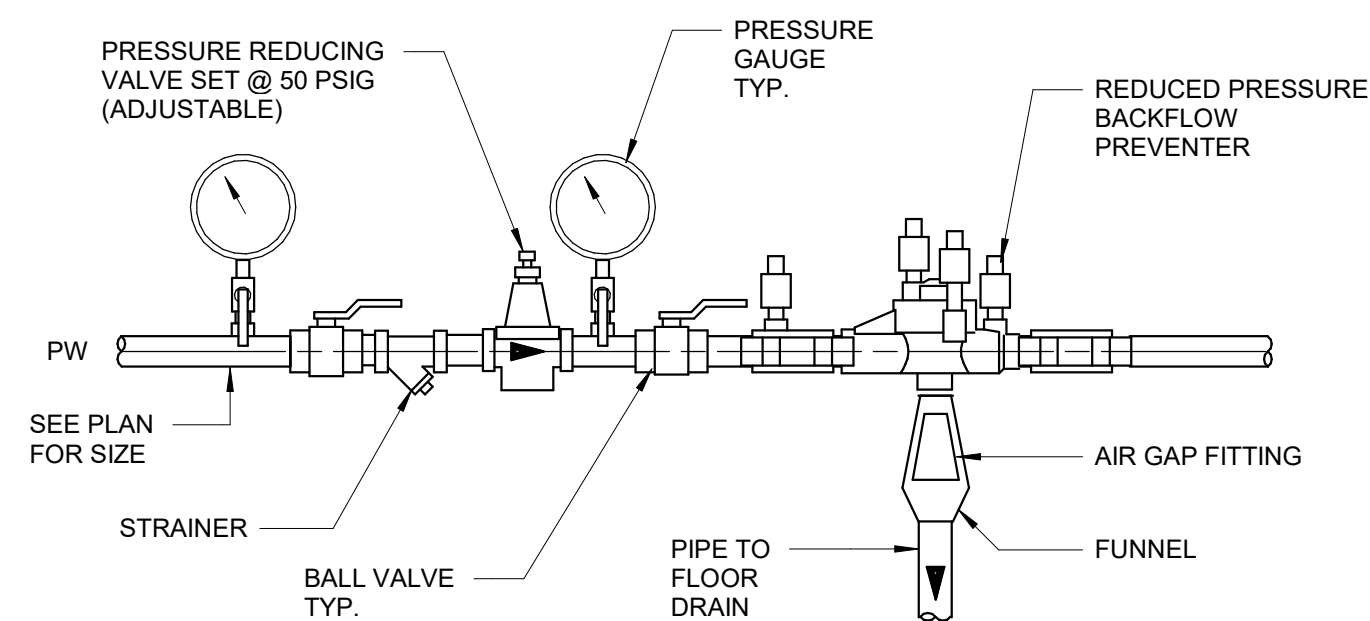
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HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H011



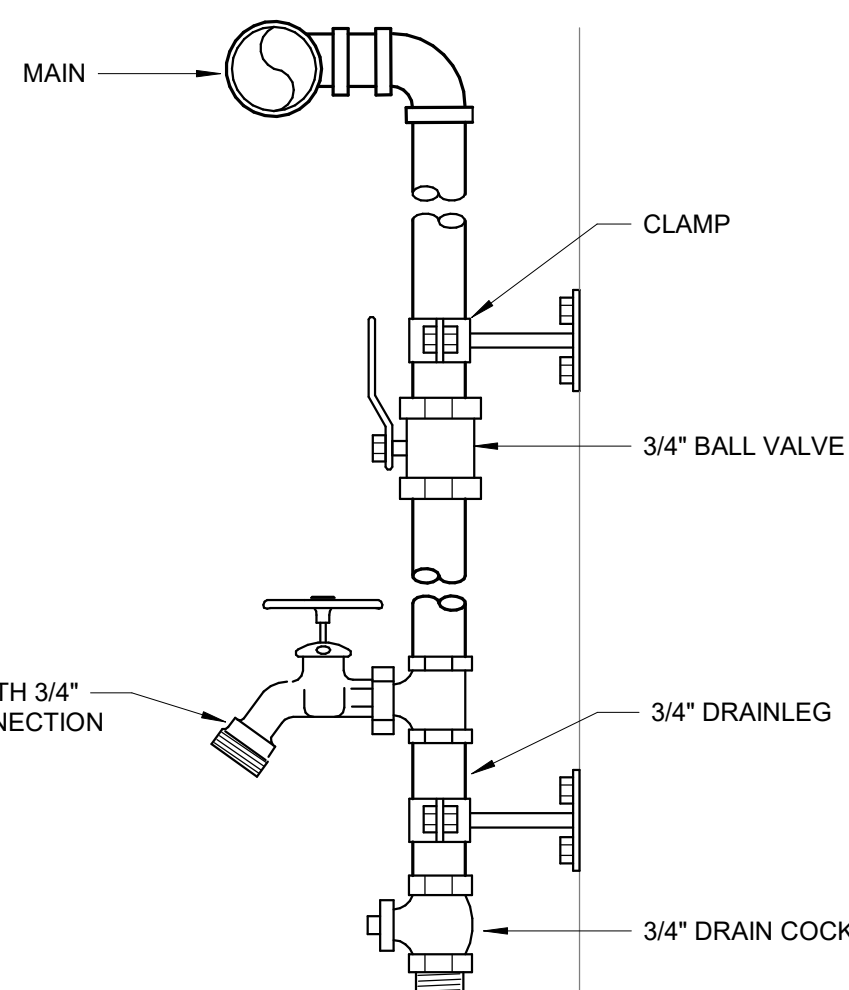
TYPICAL GOOSENECK  
H-23-0213



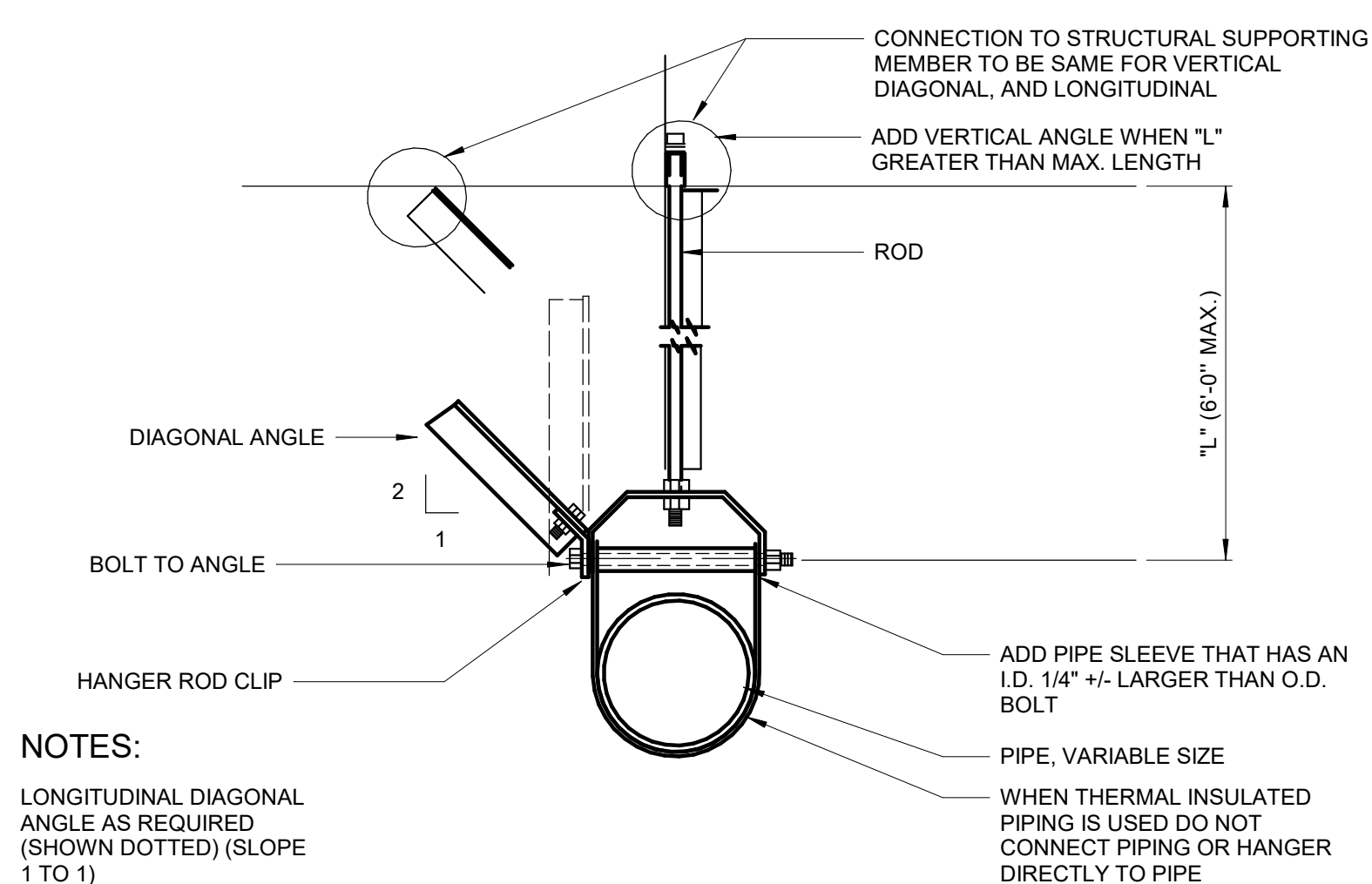
INSULATED ROOF CURB CAP  
H-23-0210



REDUCED PRESSURE ZONE ASSEMBLY  
P-22-0303

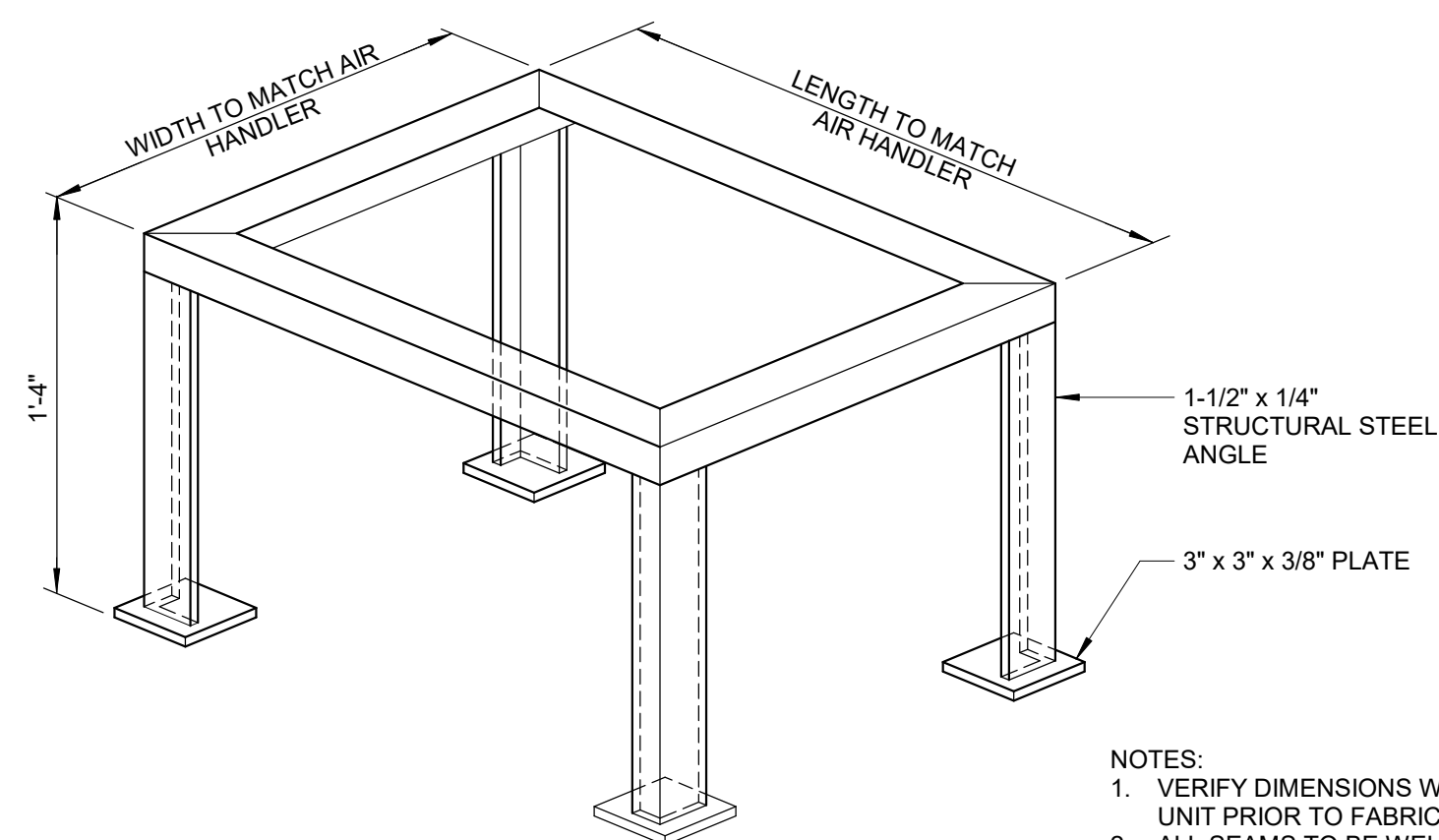


TYPICAL WATER DROP  
P-22-0304



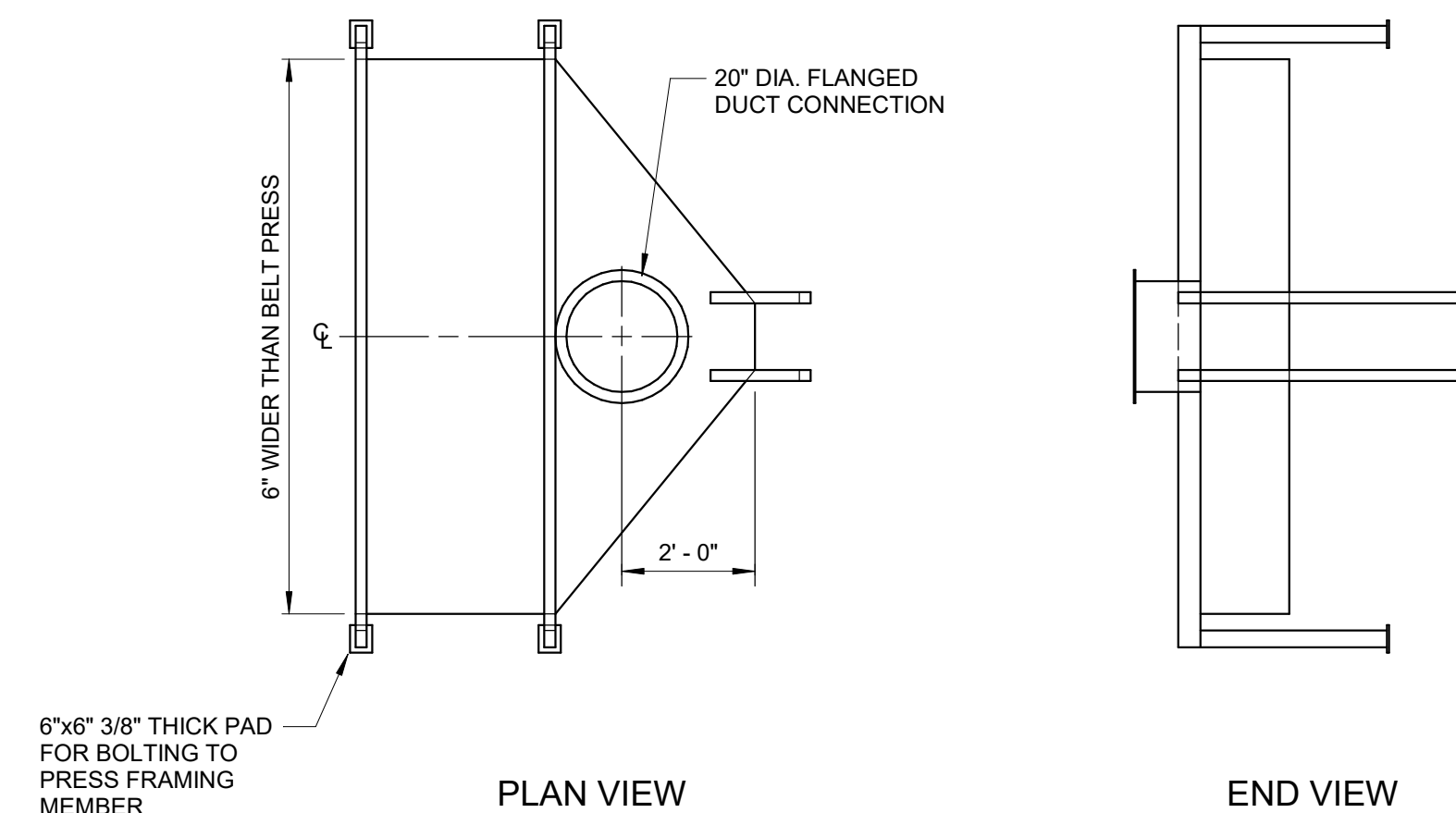
NOTES:  
LONGITUDINAL DIAGONAL ANGLE AS REQUIRED (SHOWN DOTTED) (SLOPE 1 TO 1)

SEISMIC PIPE HANGER BRACING  
H-23-0501



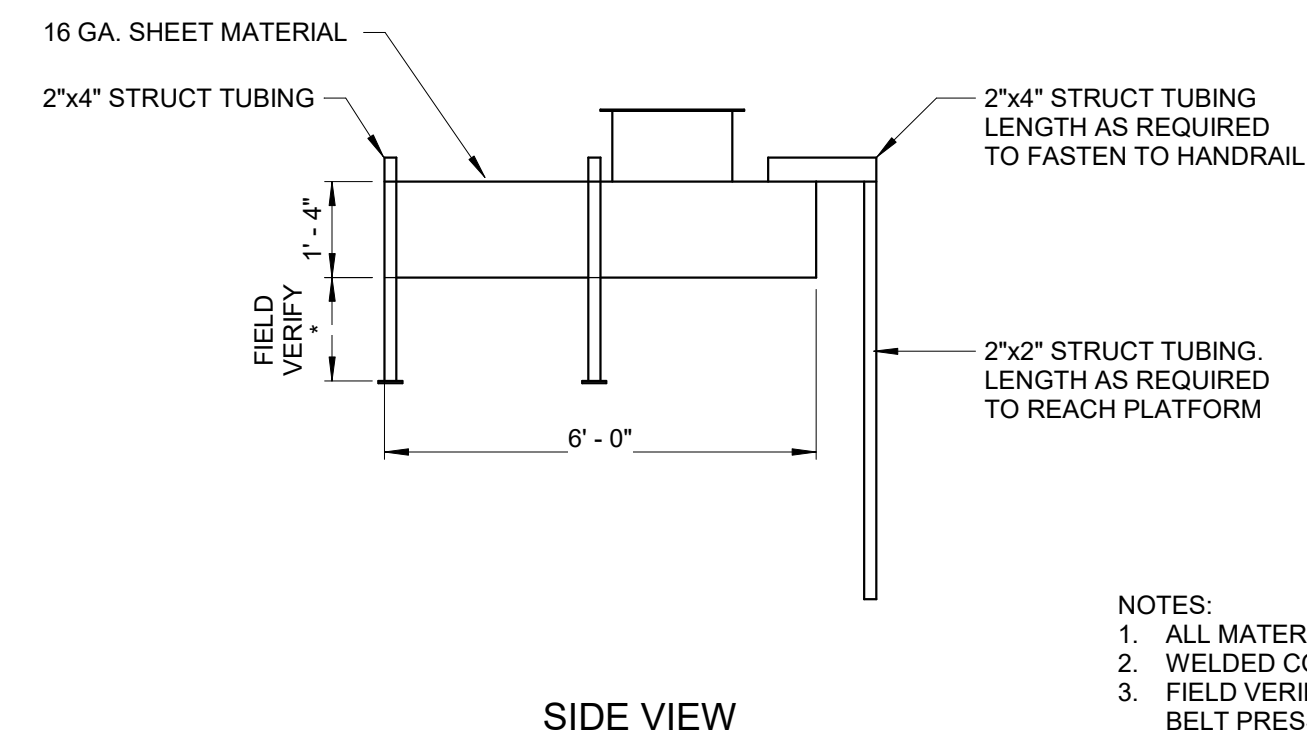
AIR HANDLER SUPPORT FRAME  
H-23-0950

NOTES:  
1. VERIFY DIMENSIONS WITH AIR HANDLING UNIT PRIOR TO FABRICATION.  
2. ALL SEAMS TO BE WELDED.  
3. PRIME AND PAINT WITH (2) COATS EPOXY.



PLAN VIEW

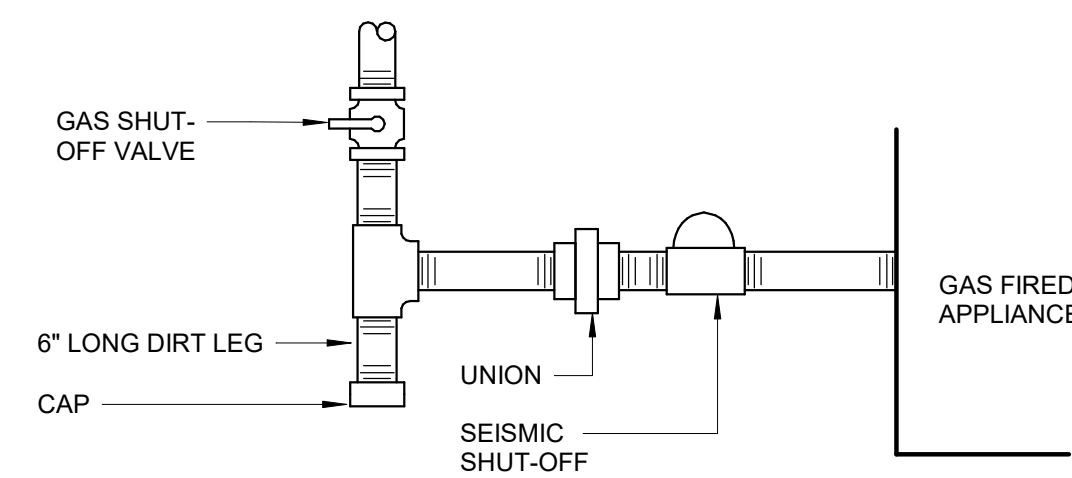
END VIEW



SIDE VIEW

PRESS EXHAUST HOOD  
H-23-0951

NOTES:  
1. ALL MATERIALS TO BE 316 STAINLESS STEEL.  
2. WELDED CONSTRUCTION  
3. FIELD VERIFY DIMENSIONS FROM GRAVITY BELT PRESS TO BE SERVED.  
4. BASE OF HOOD TO SET 1" ABOVE PRESS MECHANISM. FIELD VERIFY HEIGHT.



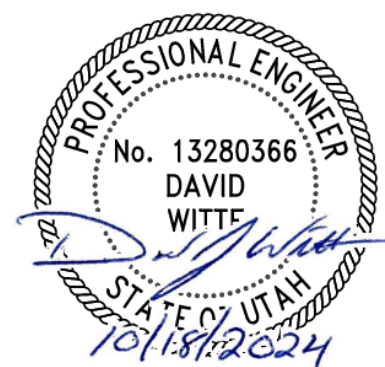
GAS FIRED APPLIANCE CONNECTION  
P-22-0106

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	T. NOLAN
CHECKED BY:	D. WITTE
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET



**Hazen**

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

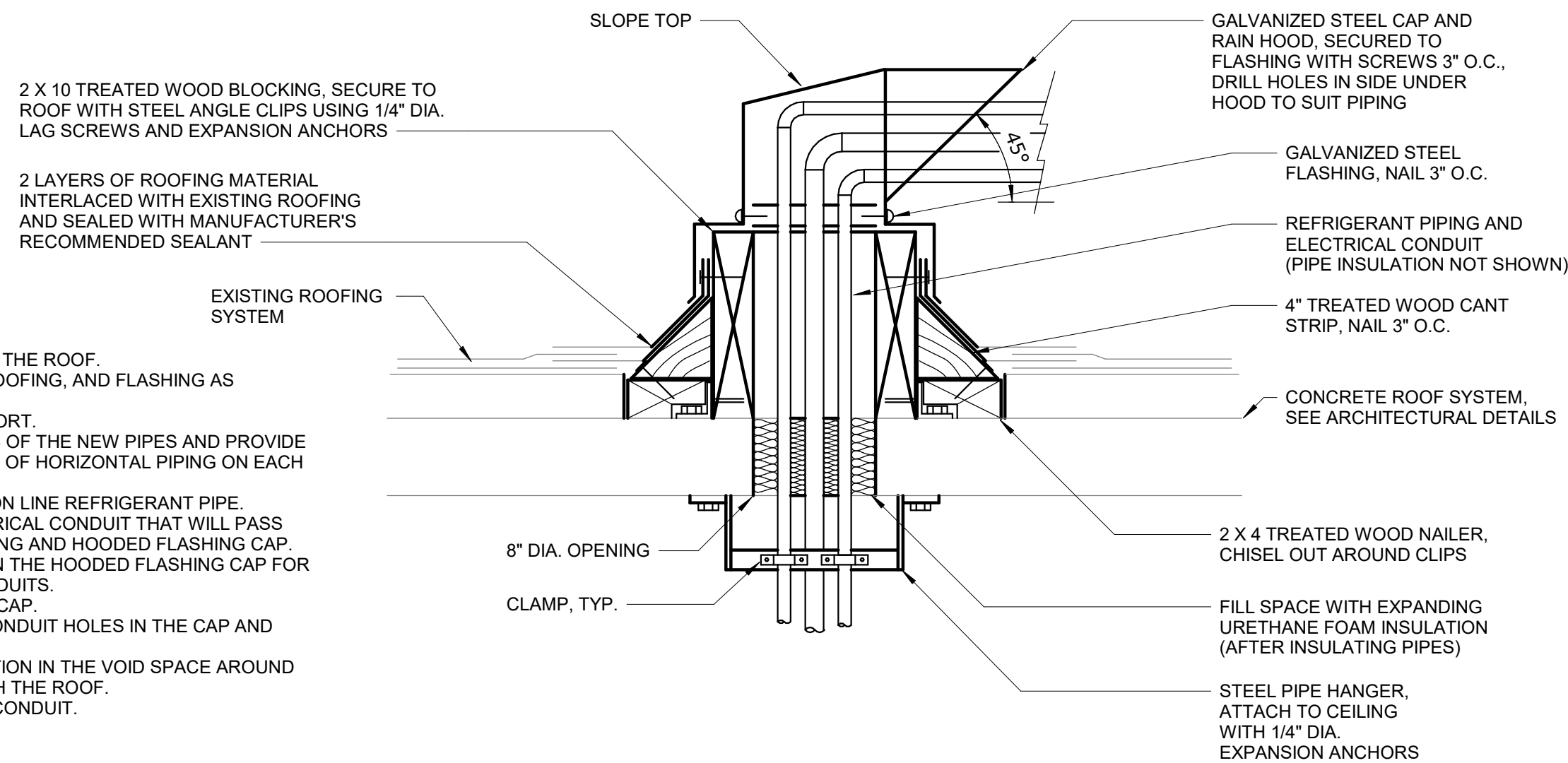
HVAC  
DETAILS 2

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H012

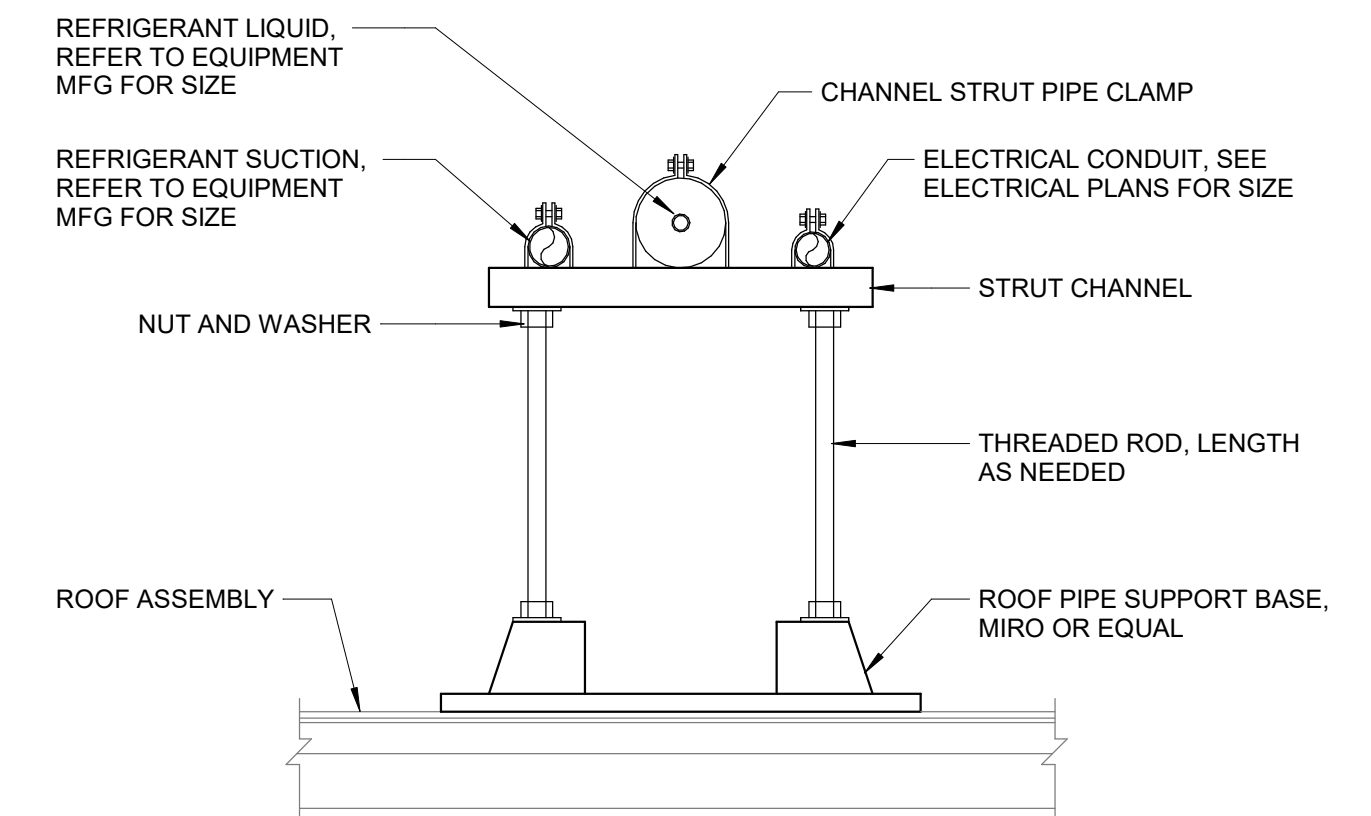


INSTALLATION SEQUENCE

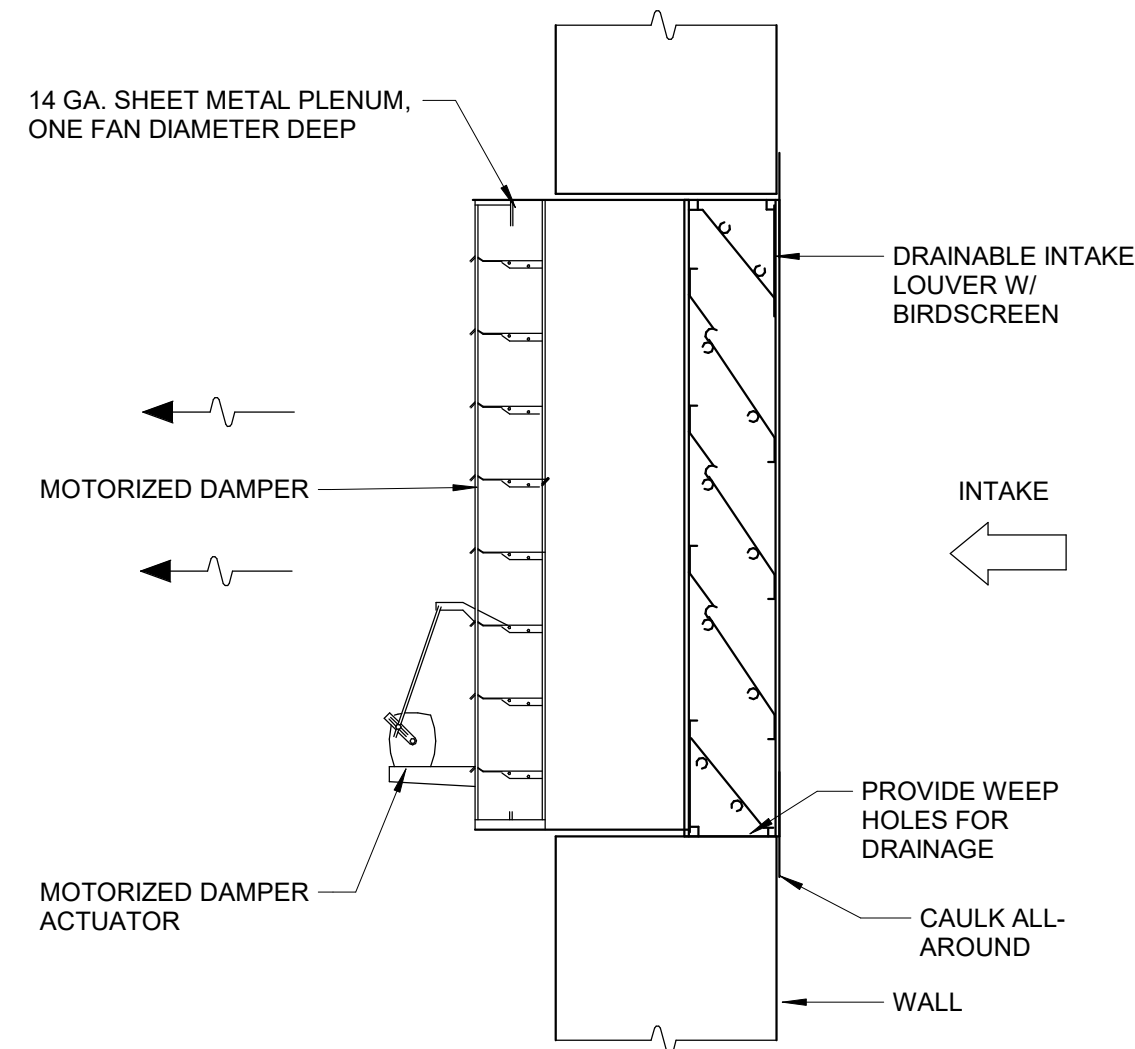
1. CORE DRILL THE HOLE THROUGH THE ROOF.
2. INSTALL THE BLOCKING, CANT, ROOFING, AND FLASHING AS INDICATED.
3. INSTALL THE PIPE HANGER SUPPORT.
4. INSTALL THE VERTICAL SECTIONS OF THE NEW PIPES AND PROVIDE AN ELBOW AND A SHORT LENGTH OF HORIZONTAL PIPING ON EACH PIPE.
5. INSULATE THE INSTALLED SUCTION LINE REFRIGERANT PIPE.
6. INSTALL THE PORTION OF ELECTRICAL CONDUIT THAT WILL PASS THROUGH THE NEW ROOF OPENING AND HOODED FLASHING CAP.
7. DRILL THREE SEPARATE HOLES IN THE HOODED FLASHING CAP FOR THE PIPES AND ELECTRICAL CONDUITS.
8. INSTALL THE HOODED FLASHING CAP.
9. CAULK AROUND THE PIPE AND CONDUIT HOLES IN THE CAP AND ALSO ALL FLASHING SEAMS.
10. SPRAY URETHANE FOAM INSULATION IN THE VOID SPACE AROUND THE PIPES IN THE HOLE THROUGH THE ROOF.
11. INSTALL REMAINING PIPING AND CONDUIT.



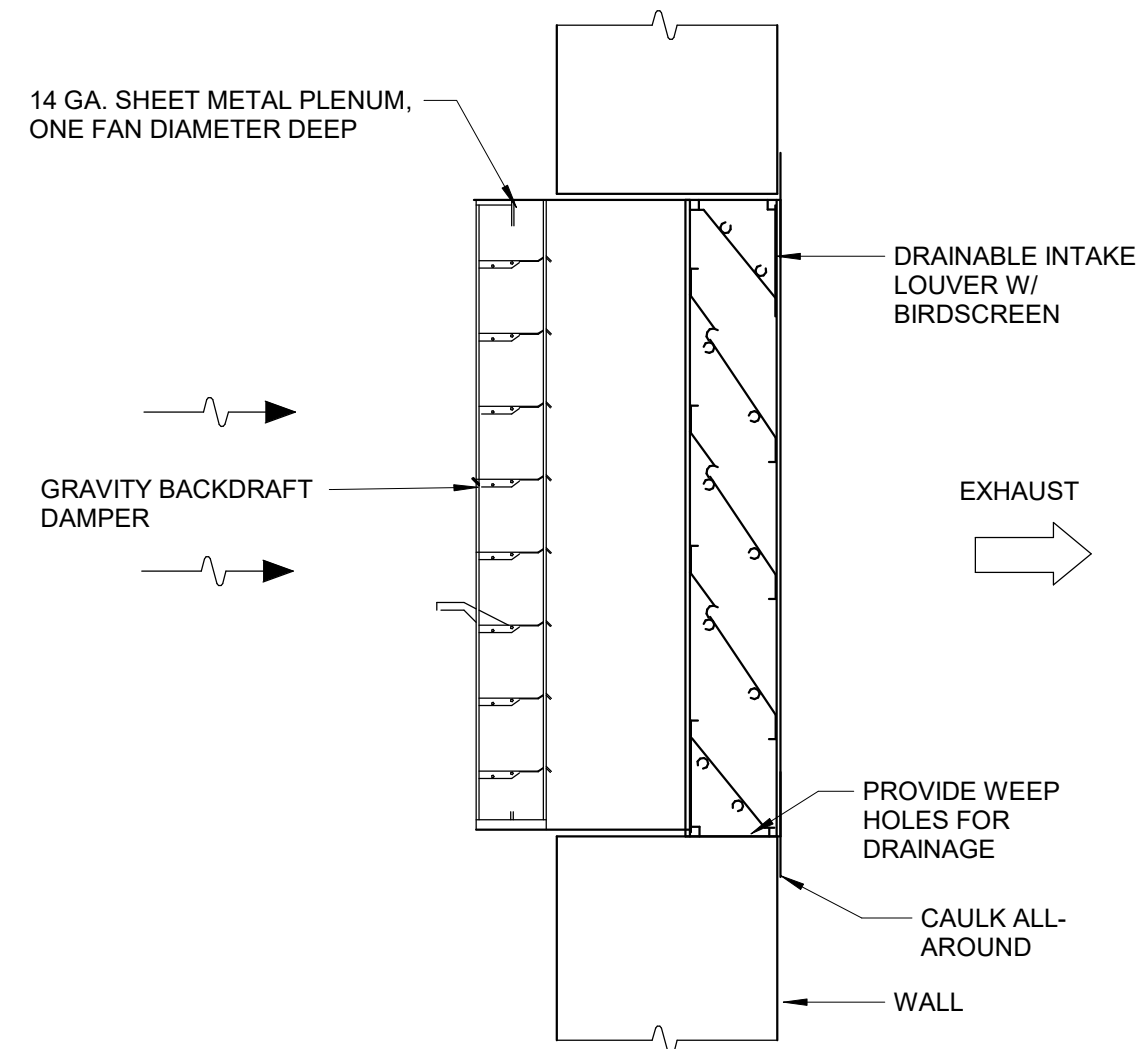
PIPING & CONDUIT ROOF PENETRATION  
H-23-0215



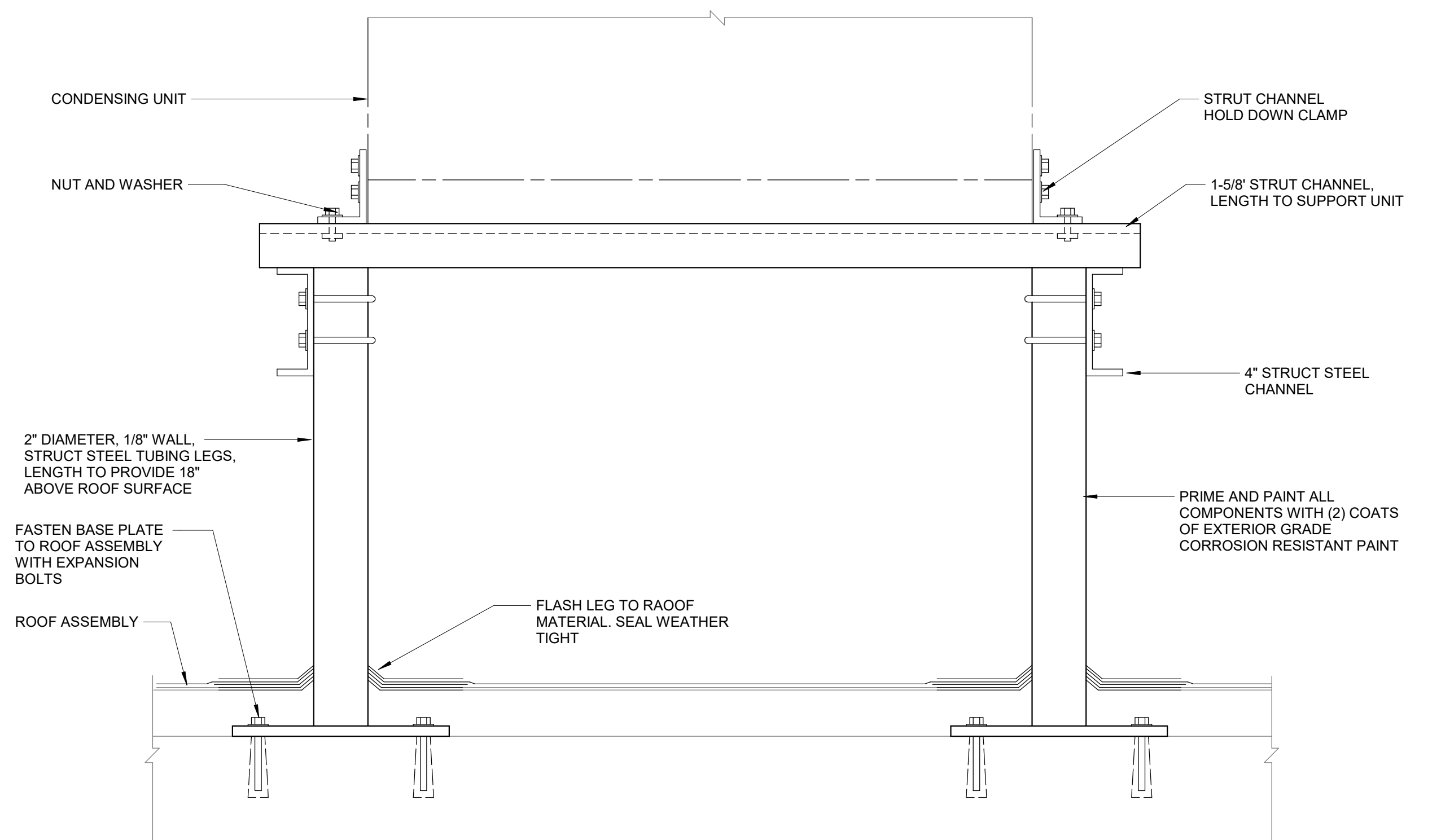
PIPING & CONDUIT ROOF SUPPORT  
H-23-0216



COMBINATION LOUVER/DAMPER  
H-23-0224



COMBINATION LOUVER/DAMPER  
H-23-0214



CONDENSING UNIT ROOF SUPPORT  
H-23-0217

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	T. NOLAN
DRAWN BY:	P. GREER
CHECKED BY:	D. WITTE

BID SET



**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

HVAC  
DETAILS 3

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	H013

**DEMOLITION**

- D-1 FOR DEMOLITION REQUIREMENTS, REFER TO SPECIFICATION 01 73 00 - DEMOLITION AND EXECUTION OF WORK.
- D-2 UNLESS ANCHORING DEVICES AND/OR REINFORCEMENT IS NOTED TO REMAIN FOLLOWING DEMOLITION, REMOVE AND/OR BURN BACK ANCHORS AND REINFORCEMENT STEEL 1/2" MIN BELOW SURFACE AND VOIDS CREATED SHALL BE FILLED WITH EPOXY RESIN BINDER.
- D-3 EMBEDDED CONDUIT ENCOUNTERED DURING DEMOLITION WORK LIMITS SHALL BE PERMANENTLY REROUTED AS NECESSARY. CONTRACTOR SHALL SUBMIT PROPOSED MEANS OF REROUTING ANY INTERFERING CONDUIT.
- D-4 PRIOR TO DEMOLITION OF SMALL OPENINGS (LESS THAN 6 INCHES IN SIZE) FOR PENETRATIONS, ETC., CONTRACTOR SHALL USE NON-DESTRUCTIVE MEANS TO FIELD LOCATE REINFORCEMENT. OPENINGS SHALL BE LOCATED TO AVOID CUTTING THROUGH EXISTING REINFORCEMENT, IF POSSIBLE. EXISTING REINFORCEMENT SHALL NOT BE CUT WITHOUT APPROVAL OF ENGINEER.
- D-5 DETAILED CONSTRUCTION AND DEMOLITION PLAN SHALL BE SUBMITTED TO THE ENGINEER AND APPROVED BY THE ENGINEER AND OWNER PRIOR TO BEGINNING CONSTRUCTION. ANY SHUTDOWNS SHALL BE SUBMITTED TO, COORDINATED WITH, AND APPROVED BY THE OWNER. ONCE APPROVED, CONTRACTOR SHALL PROVIDE A MINIMUM OF THREE (3) WEEKS NOTICE TO OWNER PRIOR TO SHUTDOWN.

**NONSTRUCTURAL COMPONENT ANCHORAGE AND BRACING**

- A-1 ANCHORAGE AND BRACING SHALL BE PROVIDED FOR NONSTRUCTURAL COMPONENTS IN ACCORDANCE WITH SPECIFICATION 01 73 23 - ANCHORAGE AND BRACING OF NONSTRUCTURAL COMPONENTS. "NONSTRUCTURAL COMPONENTS" INCLUDES ALL ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND PLUMBING ELEMENTS OR SYSTEMS (AND THEIR SUPPORTS OR ATTACHMENTS) WHICH ARE PERMANENTLY ATTACHED TO A SUPPORTING STRUCTURE. DESIGN OF ANCHORAGE AND BRACING SHALL BE PROVIDED BY CONTRACTOR'S ENGINEER UNLESS SPECIFICALLY DETAILED ON THE CONTRACT DRAWINGS.
- A-2 ANCHORAGE AND BRACING OF ALL NONSTRUCTURAL COMPONENTS SHALL BE DESIGNED AND INSTALLED TO RESIST THE CONTROLLING LOAD COMBINATION OF GRAVITY LOADS, OPERATIONAL FORCES, WIND FORCES, SEISMIC FORCES, AND ANY OTHER APPLICABLE FORCES IN ACCORDANCE WITH THE GOVERNING BUILDING CODE. WIND AND SEISMIC FORCES SHALL BE AS PER ASCE 7. COMPONENTS SHALL BE BOLTED, WELDED, OR OTHERWISE POSITIVELY FASTENED WITHOUT CONSIDERATION OF FRICTIONAL RESISTANCE PRODUCED BY THE EFFECTS OF GRAVITY. A CONTINUOUS LOAD PATH OF SUFFICIENT STRENGTH AND STIFFNESS TO RESIST REQUIRED FORCES SHALL BE PROVIDED BETWEEN THE COMPONENT AND THE SUPPORTING STRUCTURE. ANCHORAGE AND BRACING SHALL BE DESIGNED TO RESIST LOADS IN BOTH ORTHOGONAL DIRECTIONS (TRANSVERSE AND LONGITUDINAL) AND SHALL BE DESIGNED AND SEALED BY THE CONTRACTOR'S ENGINEER CURRENTLY REGISTERED IN THE STATE OF UTAH.
- A-3 COMPONENT REACTION FORCES AT THE POINT OF ATTACHMENT TO THE STRUCTURE SHALL BE SUBMITTED TO AND COORDINATED WITH THE ENGINEER FOR CONFIRMATION THAT SUPPORTING STRUCTURE IS ADEQUATE TO RESIST REQUIRED REACTION FORCES.
- A-4 CONTRACTOR SHALL PROVIDE SPECIAL SEISMIC CERTIFICATION (SSC) FROM MANUFACTURER OF EQUIPMENT FOR ALL SYSTEMS REQUIRED BY SPECIFICATIONS. SPECIAL SEISMIC CERTIFICATION SHALL BE IN COMPLIANCE WITH ASCE 7.

**MASONRY**

- MA-1 MASONRY MORTAR SHALL BE ASTM C 270 TYPE "S" AND MASONRY GROUT SHALL CONFORM TO REQUIREMENTS OF ASTM C 476.
- MA-2 CONCRETE MASONRY UNIT NET AREA COMPRESSIVE STRENGTH SHALL BE 2,000 PSI WHEN TESTED IN ACCORDANCE WITH ASTM C 140. COMPLETE TEST REPORTS SHALL BE SUBMITTED TO THE BUILDING INSPECTOR.
- MA-3 VERTICAL REINFORCEMENT SHALL BE PROVIDED AT WALL ENDS, CORNERS, AND INTERSECTIONS AND IMMEDIATELY ADJACENT TO ALL OPENINGS, CONTROL JOINTS, AND COLUMNS. SEE STANDARD DETAILS FOR MASONRY OPENINGS.
- MA-4 MASONRY REINFORCEMENT LAP SPLICES SHALL BE CONTACT SPLICES. UNLESS NOTED OTHERWISE, LENGTH OF SPLICE FOR SINGLE BARS IN CENTER OF CELLS OF 8" OR LARGER CMU SHALL BE A MINIMUM OF 25 INCHES FOR #4 BARS, 32 INCHES FOR #5 BARS, AND 50 INCHES FOR #6 BARS. LENGTH OF SPLICE FOR OTHER CONDITIONS SHALL BE AS SHOWN ON THE DRAWINGS.

**STRUCTURAL METALS**

- M-1 DETAIL, FABRICATE, AND ERECT STRUCTURAL STEEL IN ACCORDANCE WITH ANS/AISC 360 SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS, LATEST EDITION.
- M-2 STEEL MATERIAL:
  - A) STRUCTURAL HSS: ASTM A500, GRADE C (46/50 KSI) OR A1085 GRADE A (50 KSI)
  - B) STRUCTURAL PIPE: ASTM A53, GRADE B (35 KSI)
  - C) PLATES, BARS AND ANGLES: ASTM A36 UNO (36 KSI)
  - D) STRUCTURAL W, C, & MC SHAPES: ASTM A992 (50 KSI)
  - E) STRUCTURAL M & S SHAPES: ASTM A36 (36 KSI)
  - F) STRUCTURAL HP: ASTM A572 GRADE 50 (50 KSI)
  - G) ANCHOR RODS: ASTM F1554 GRADE 55 (55 KSI)
- M-3 PROVIDE MINIMUM 3/4" DIAMETER ASTM F3125 GRADE A325 TYPE 1 OR GRADE F1852 TYPE 1 HIGH STRENGTH BOLTS WITH SNUG TIGHTENED TYPE N CONNECTIONS FOR STRUCTURAL STEEL UNLESS NOTED OTHERWISE. HOLES FOR BOLTS SHALL BE STANDARD SIZE UNLESS NOTED OTHERWISE.
- M-4 PROVIDE TYPICAL STEEL BEAM CONNECTIONS FOR A CAPACITY OF NOT LESS THAN ONE HALF OF THE TOTAL UNIFORM LOAD CAPACITY TABULATED IN THE AISC TABLES FOR ALLOWABLE LOADS OF BEAMS UNLESS NOTED OTHERWISE.
- M-5 DO NOT PAINT STEEL SURFACES WHICH ARE TO BE WELDED OR ARE TO BE ENCASED IN CONCRETE.
- M-6 DETAIL, FABRICATE, AND ERECT STRUCTURAL STAINLESS STEEL IN ACCORDANCE WITH ANS/AISC 370 SPECIFICATION FOR STRUCTURAL STAINLESS STEEL BUILDINGS, LATEST EDITION. ALL STAINLESS STEEL FABRICATIONS EXPOSED TO UNDERWATER SERVICE, IN CONFINED AREAS CONTAINING FLUID, AND IN CORROSIVE ENVIRONMENTS SHALL BE TYPE 316. ALL OTHER STAINLESS STEEL FABRICATIONS SHALL BE TYPE 304 UNLESS NOTED OTHERWISE.
- M-7 ALL BOLTS, ANCHORS, AND CONCRETE ANCHORS CONNECTING ALUMINUM OR STAINLESS STEEL SHALL BE STAINLESS STEEL TYPE 316 FOR UNDERWATER APPLICATIONS, IN CONFINED AREAS CONTAINING FLUID, AND IN CORROSIVE ENVIRONMENTS AND TYPE 304 FOR ALL OTHER APPLICATIONS.
- M-8 ALL GROOVE AND BUTT WELDS SHALL BE FULL PENETRATION.
- M-9 FILLET WELD SIZES SHALL NOT BE LESS THAN THE MINIMUM SIZE REQUIRED BY AISC CODE FOR PLATE SIZES TO BE CONNECTED AND SHALL BE APPLIED TO THE ENTIRE JOINT CONTACT LENGTH, AND NOT LESS THAN 3/16".
- M-10 ALL WELDS SHALL BE PERFORMED IN THE SHOP UNLESS NOTED BY A FIELD WELD SYMBOL OR APPROVED BY ENGINEER.
- M-11 BOTTOM SURFACES OF BASE PLATES SHALL BE GROUTED TO ENSURE FULL BEARING CONTACT WITH CONCRETE SLAB.
- M-12 WHENEVER ONE MEMBER IS FASTENED TO ANOTHER WITH FASTENINGS (BOLTS, WELDS, ETC.) SET AT A UNIFORM SPACING, A MINIMUM OF TWO FASTENINGS PER PIECE SHALL BE CONNECTED AND THE FIRST AND LAST FASTENINGS SHALL BE LOCATED NOT TO EXCEED 0.25 OF FASTENER SPACING FROM EACH END.

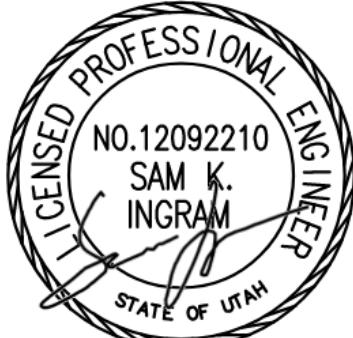
**GENERAL STRUCTURAL NOTES**

- G-1 THESE NOTES ARE GENERAL AND SUPPLEMENT THE SPECIFICATIONS. THESE NOTES APPLY TO THE ENTIRE PROJECT UNLESS MODIFIED OR NOTED OTHERWISE IN THE CONTRACT DOCUMENTS.
- G-2 STANDARD DETAILS SHALL BE USED WHEN REFERRED TO OR WHEN NO MORE RESTRICTIVE OR DIFFERENT DETAILS ARE SHOWN ON THE DRAWINGS.
- G-3 DESIGN IS IN ACCORDANCE WITH AND CONSTRUCTION SHALL COMPLY WITH THE PROVISIONS OF THE 2021 INTERNATIONAL BUILDING CODE. THE DESIGN LOADS AND OTHER DESIGN VALUES GIVEN IN NOTES G-4 THROUGH G-8 WERE USED FOR DESIGN OF STRUCTURES UNLESS NOTED OTHERWISE ON THE DRAWINGS.
- G-4 ALL DIMENSIONS INDICATED FOR EXISTING STRUCTURES SHALL BE VERIFIED BY FIELD MEASUREMENT. ALL DIMENSIONS THAT ARE CONTROLLED BY OR RELATED TO EQUIPMENT SHALL BE VERIFIED BY THE CONTRACTOR WITH THE MANUFACTURER SHOP DRAWINGS PRIOR TO CONSTRUCTION.
- G-5 THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL EXISTING INFORMATION IN THE FIELD AS REQUIRED FOR NEW WORK.
- G-6 IF A CONFLICT IS FOUND BETWEEN DIFFERENT PORTIONS OF THE CONTRACT DOCUMENTS, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY. CONTINUED CONSTRUCTION OF THE AREA IN CONFLICT SHALL BE AT THE CONTRACTOR'S OWN RISK UNTIL THE CONFLICT IS RESOLVED.
- G-7 EQUIPMENT ANCHOR SIZES, TYPES, EMBEDMENT AND PATTERNS SHALL BE DESIGNED BY THE MANUFACTURER OF THE EQUIPMENT. IF EQUIPMENT MANUFACTURER IS UNABLE TO PROVIDE DESIGN OF ANCHOR EMBEDMENT, DESIGN SHALL BE BY ENGINEER RETAINED BY CONTRACTOR BASED ON LOADS PROVIDED BY EQUIPMENT MANUFACTURER. CONTRACTOR SHALL SUBMIT SIZE, PLACEMENT, AND EMBEDMENT REQUIREMENTS. ALL ANCHOR PATTERNS SHALL BE TEMPLATED TO ENSURE ACCURACY OF PLACEMENT.
- G-8 DURING CONSTRUCTION, THE STRUCTURES SHALL BE PROTECTED BY BRACING AND TEMPORARY SUPPORTS WHEREVER EXCESSIVE CONSTRUCTION LOADS MAY OCCUR. OVERSTRESSING OF ANY STRUCTURAL ELEMENT IS PROHIBITED.
- G-9 IF CONTRACTOR DESIRES TO TEMPORARILY PLACE OR MOVE LOADS ON OR ADJACENT TO EXISTING STRUCTURES OR UTILITIES DURING CONSTRUCTION PROCESS, CONTRACTOR IS EXCLUSIVELY RESPONSIBLE FOR MAINTAINING STRUCTURAL INTEGRITY AND AVOIDING OVERSTRESSING AND DAMAGING EXISTING STRUCTURES AND UTILITIES. CONTRACTOR SHALL SUBMIT STRUCTURAL CALCULATIONS AND DRAWINGS VERIFYING THAT PROPOSED CONSTRUCTION (INCLUDING APPLICATION OF TEMPORARY CONSTRUCTION LOADS) WILL NOT OVERSTRESS OR DAMAGE EXISTING STRUCTURES AND UTILITIES. DRAWINGS AND CALCULATIONS SHALL BE SEALED BY A PROFESSIONAL ENGINEER CURRENTLY REGISTERED IN THE STATE OF UTAH.

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				PROJECT ENGINEER: C. THUNHORST
				DESIGNED BY: S. INGRAM
				DRAWN BY: A. TREJO
				CHECKED BY: C. THUNHORST
1	BID SET	10/2024	CNT	IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE
REV	ISSUED FOR	DATE	BY	

BID SET



10/17/24

# Hazen

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

**CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT**

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**DEWATERING BUILDING HVAC  
IMPROVEMENTS**

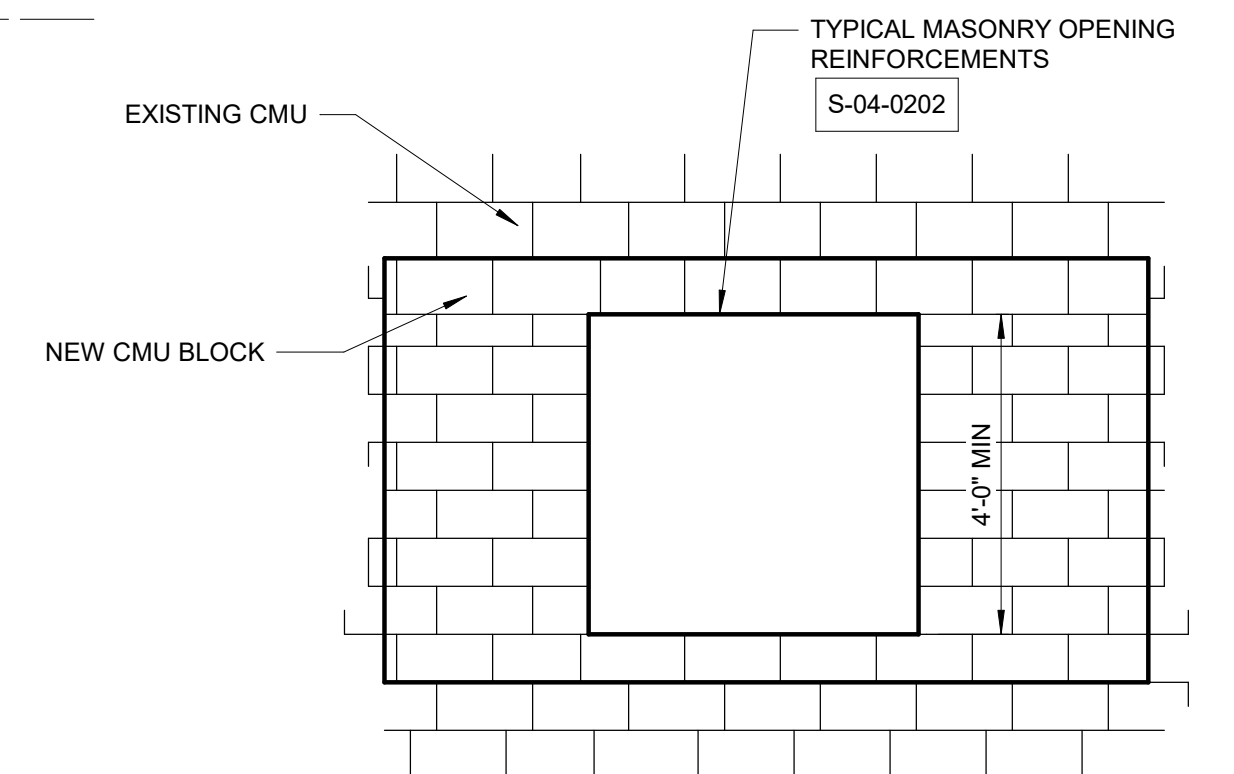
**STRUCTURAL  
GENERAL NOTES**

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S001

NOTES:

- BID ALT 2 - ALL STRUCTURAL STEEL (BEAMS AND COLUMNS) AND ALL CEILING PANELS IN SHADED AREA SHALL BE SANDBLASTED, CLEANED, AND PAINTED. SEE S005 FOR PHOTOS. SHADED AREAS COVER PUMP ROOM AND TRUCK BAY.
- STRUCTURAL STEEL (BEAMS AND COLUMNS) LOCATIONS SHOWN ARE BASED ON RECORD DRAWINGS AND LIMITED FIELD INVESTIGATION. FIELD COORDINATE EXACT QUANTITY AND LOCATIONS.

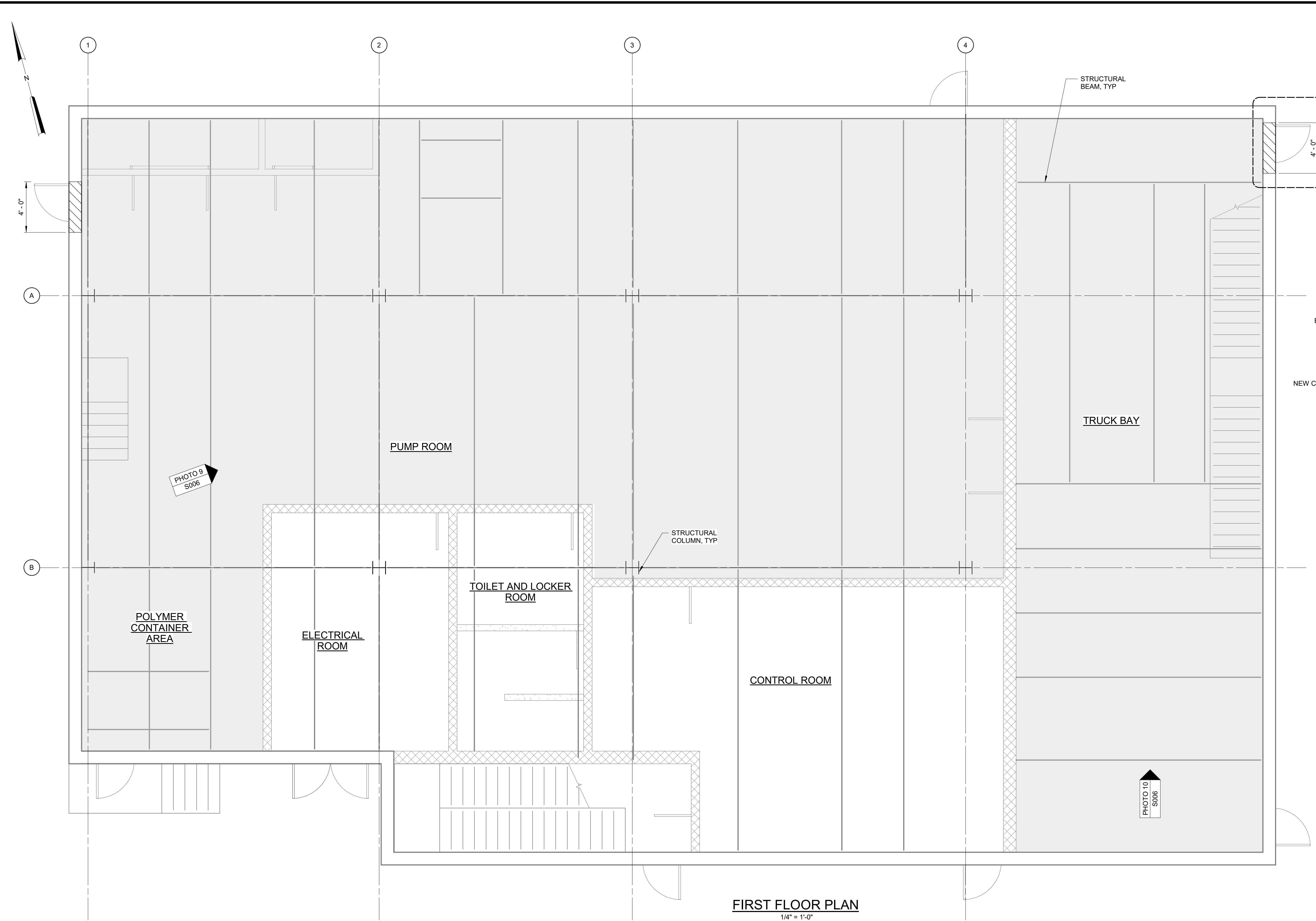
2 TYP  
S002



- NOTE:
- CONTRACTOR SHALL FIELD VERIFY REQUIRED LOCATION, ELEVATION, AND SIZE OF OPENING ABOVE DOORWAY AND SUBMIT PLANS TO ENGINEER FOR REVIEW

- NEW CMU BLOCK SHALL MATCH EXISTING

DETAIL 2  
1/2" = 1'-0"  
S002



FIRST FLOOR PLAN  
1/4" = 1'-0"

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET

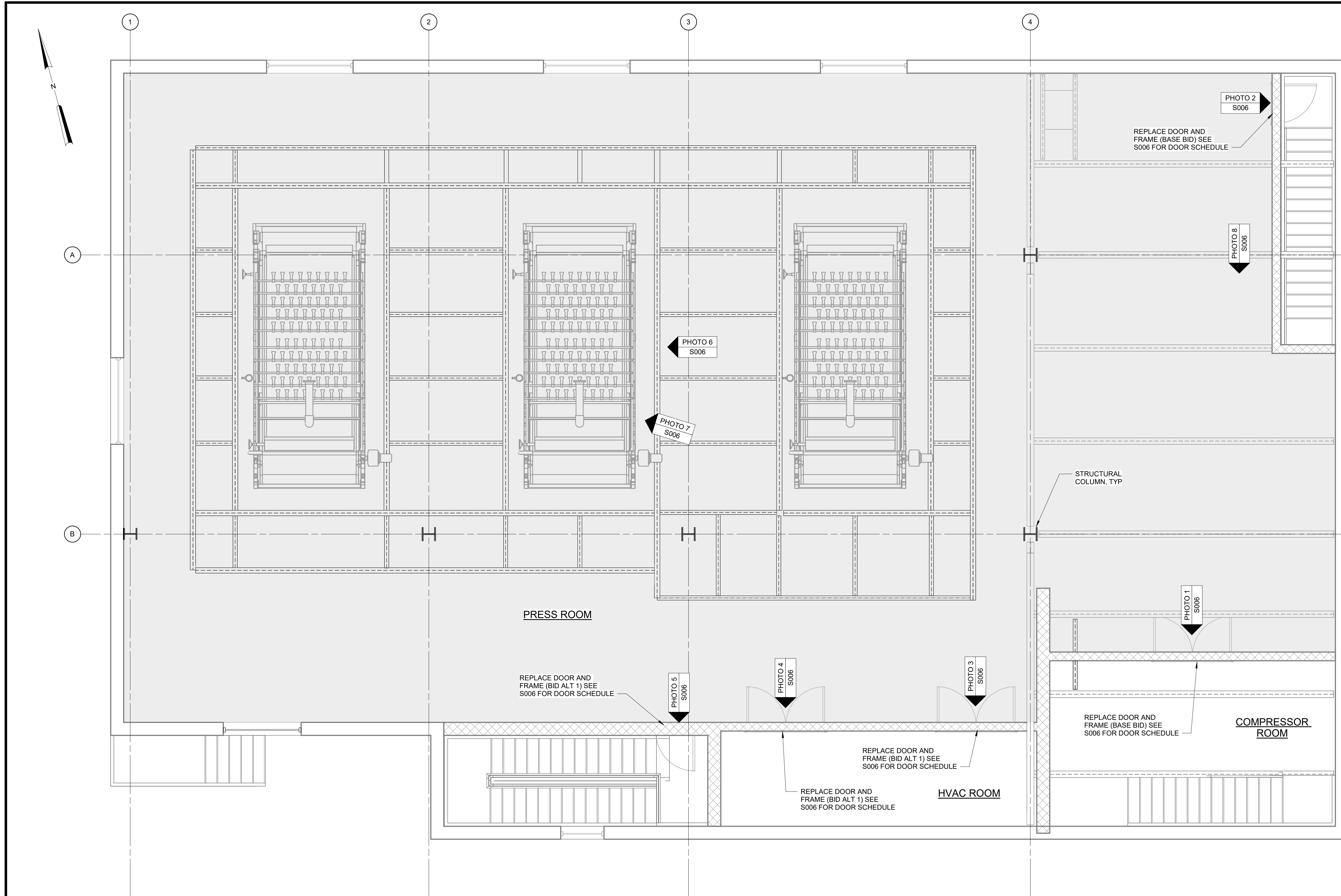


**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
FIRST FLOOR PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S002



- NOTES:**
- BID ALT 2 - ALL STRUCTURAL STEEL (BEAMS AND COLUMNS) AND ALL CEILING PANELS IN SHADED AREA SHALL BE SANDBLASTED, CLEANED, AND PAINTED. SEE S005 FOR PHOTOS. SHADED AREAS COVER PUMP ROOM AND TRUCK BAY.
  - STRUCTURAL STEEL (BEAMS AND COLUMNS) LOCATIONS SHOWN ARE BASED ON RECORD DRAWINGS AND LIMITED FIELD INVESTIGATION. FIELD COORDINATE EXACT QUANTITY AND LOCATIONS. REFER TO THE ROOF FRAMING PLAN FOR BEAMS LOCATED ABOVE SLUDGE PRESSES.

**SECOND FLOOR LOWER PLAN**  
1/4" = 1'-0"

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST

BID SET



**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

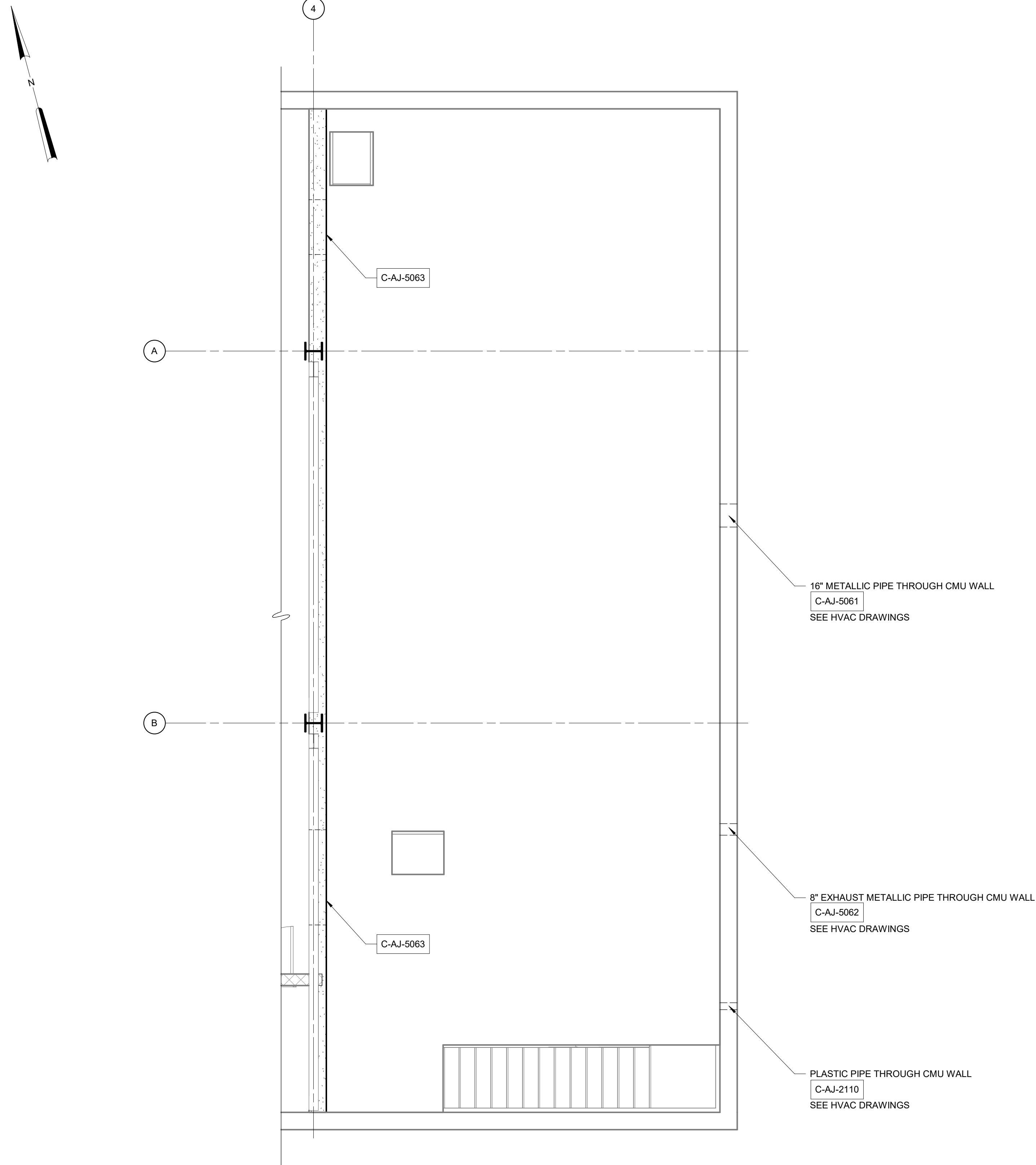
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
SECOND FLOOR LOWER PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S003



- NOTES:
1. NEW OPENINGS IN CMU WALL SHALL BE REINFORCED WHERE BUILDING MAIN REINFORCEMENTS ARE INTERRUPTED. SEE DETAIL S-04-0202.



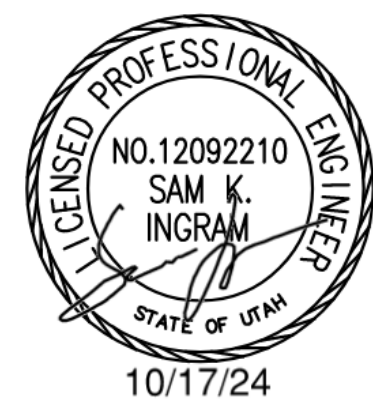
**MEZZANINE PLAN**  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-S.rvt  
10/21/2024 4:08:12 PM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST

BID SET

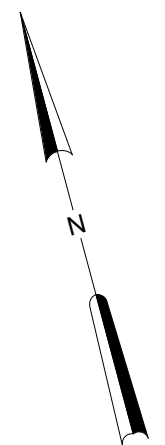


**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

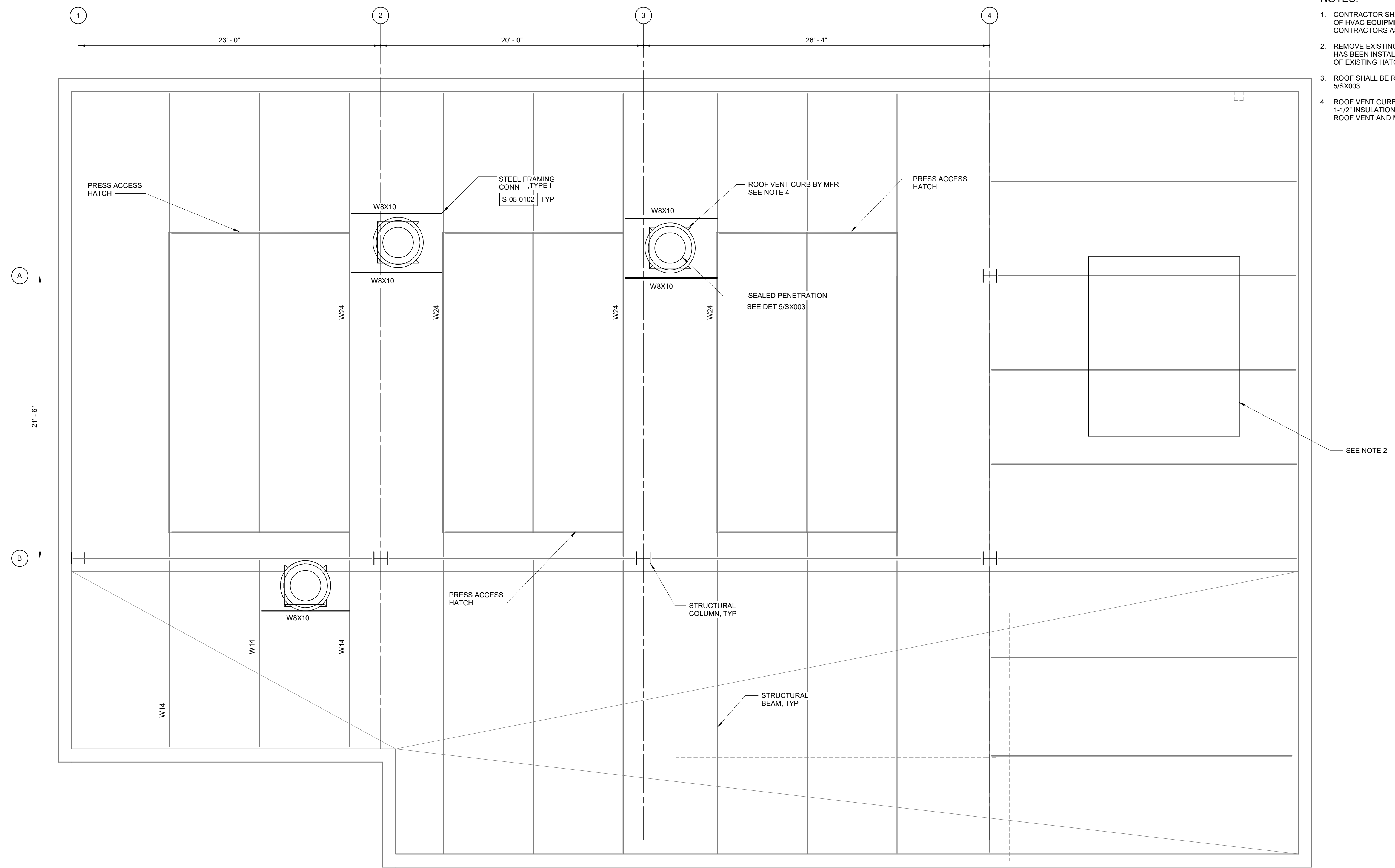
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
MEZZANINE PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S004



- NOTES:**
1. CONTRACTOR SHALL INSTALL STEEL FRAMING MEMBERS AT NEW OPENINGS OF HVAC EQUIPMENT IN ROOF. FRAMING MEMBERS SHALL BE LOCATED BY CONTRACTORS AS CLOSE TO THE HVAC EQUIPMENT AS PRACTICAL.
  2. REMOVE EXISTING HATCH AND INSTALL NEW HATCH AFTER HVAC EQUIPMENT HAS BEEN INSTALLED. NEW HATCH SHALL MATCH TYPE, MATERIAL, AND SIZE OF EXISTING HATCH. SUBMIT DETAILS OF NEW HATCH TO ENGINEER REVIEW.
  3. ROOF SHALL BE REPAIRED AND SEALED AT NEW OPENINGS. REFER TO DETAIL 5/SX003
  4. ROOF VENT CURB SHALL BE PRE-FABRICATED METAL CURB SYSTEM WITH 1-1/2" INSULATION. CONTRACTOR SHALL COORDINATE INSTALLATION WITH ROOF VENT AND METAL CURB MANUFACTURERS.



**ROOF FRAMING PLAN**  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSIDS.rvt 10/21/2024 4:08:12 PM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET



**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

STRUCTURAL  
ROOF FRAMING PLAN

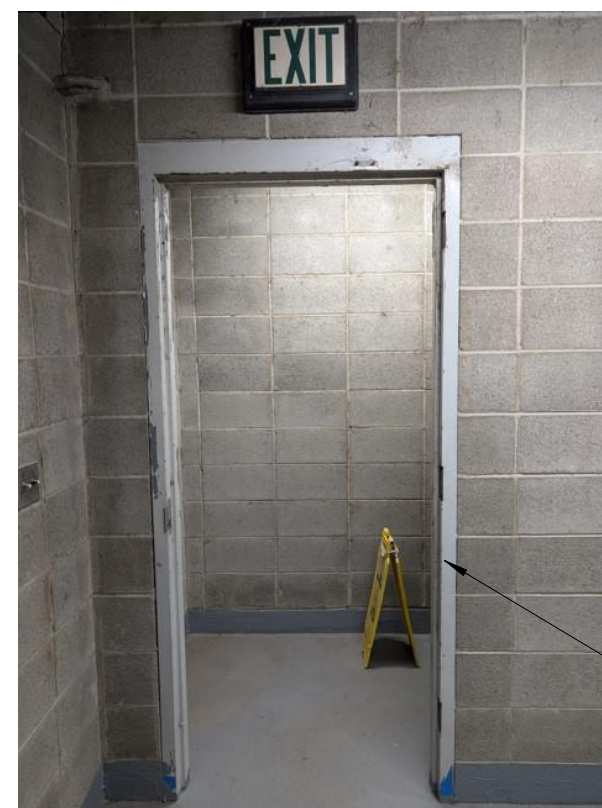
DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S005





DOOR 1

PHOTO 1  
NO SCALE S003



DOOR 2

PHOTO 2  
NO SCALE S003

- NOTES:
- FIELD VERIFY EXISTING DOOR FRAME SIZE AND MATERIAL. REMOVE EXISTING FRAME AND INSTALL NEW DOOR FRAME AND DOOR SEAL, IN KIND.
  - BID ALT 2 - SANDBLAST AND CLEAN ALL STRUCTURAL STEEL. PAINT STEEL BEAMS, COLUMNS, AND ROOF PANELS WITH PROTECTIVE COATING PER SPECIFICATION 09 90 00. TWO PRESSES TO REMAIN OPERATIONAL AT ALL TIMES. COORDINATE WITH OWNER.

NO.	FRAME		DOOR					GLASS	FINISH	REMARKS
	TYPE	MATL	TYPE	MATL	WIDTH	HEIGHT	THICKNESS			
1	F-2	HM	B	HM	5'-0"	7'-0"	1 3/4"	--	PT	BASE BID, MATCH EXISTING DOOR IN KIND
2	F-1	HM	A	HM	3'-0"	7'-0"	1 3/4"	TG	PT	BASE BID, MATCH EXISTING DOOR IN KIND
3	F-2	HM	B	HM	5'-0"	7'-0"	1 3/4"	--	PT	BID ALT 1, MATCH EXISTING DOOR IN KIND
4	F-2	HM	B	HM	5'-0"	7'-0"	1 3/4"	--	PT	BID ALT 1, MATCH EXISTING DOOR IN KIND
5	F-1	HM	A	HM	3'-0"	7'-0"	1 3/4"	TG	PT	BID ALT 1, MATCH EXISTING DOOR IN KIND

DOOR LEGEND	DOOR SCHEDULE NOTES:
HM HOLLOW METAL PT PAINT TG TEMPERED GLASS	1. GLASS SHALL BE 1/2" FIXED TEMPERED SAFETY TYPE IN DOORS. 2. PROVIDE WEATHER STRIPPING AND DOOR BOTTOM SEAL.



DOOR 3

PHOTO 3  
NO SCALE S003



DOOR 4

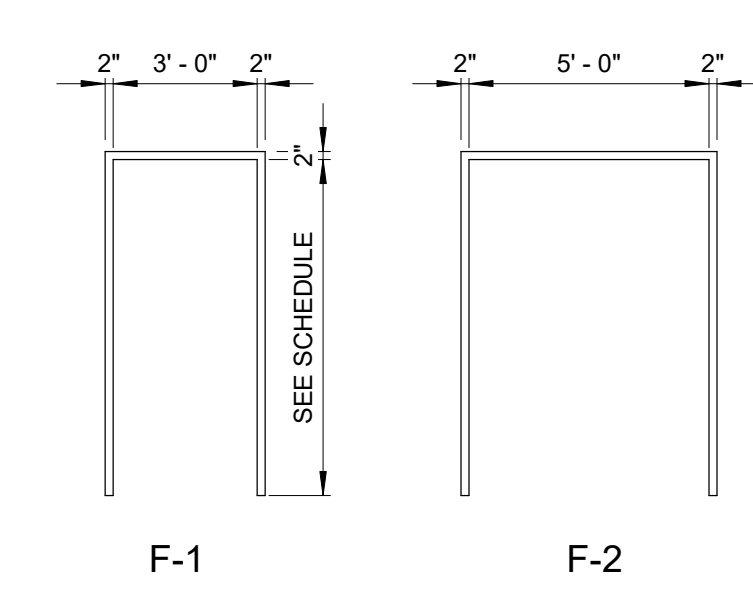
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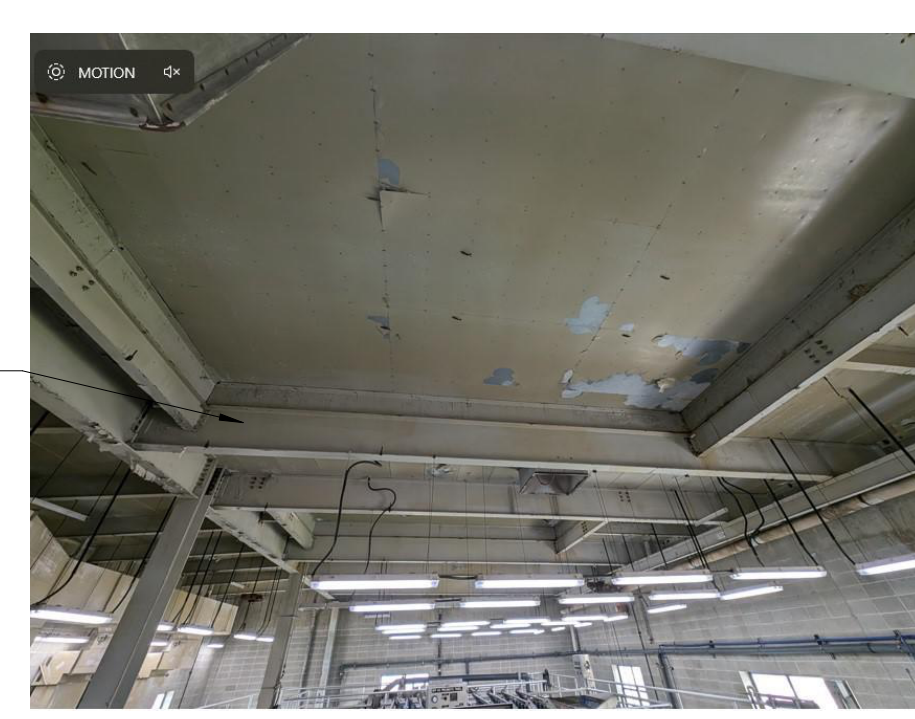
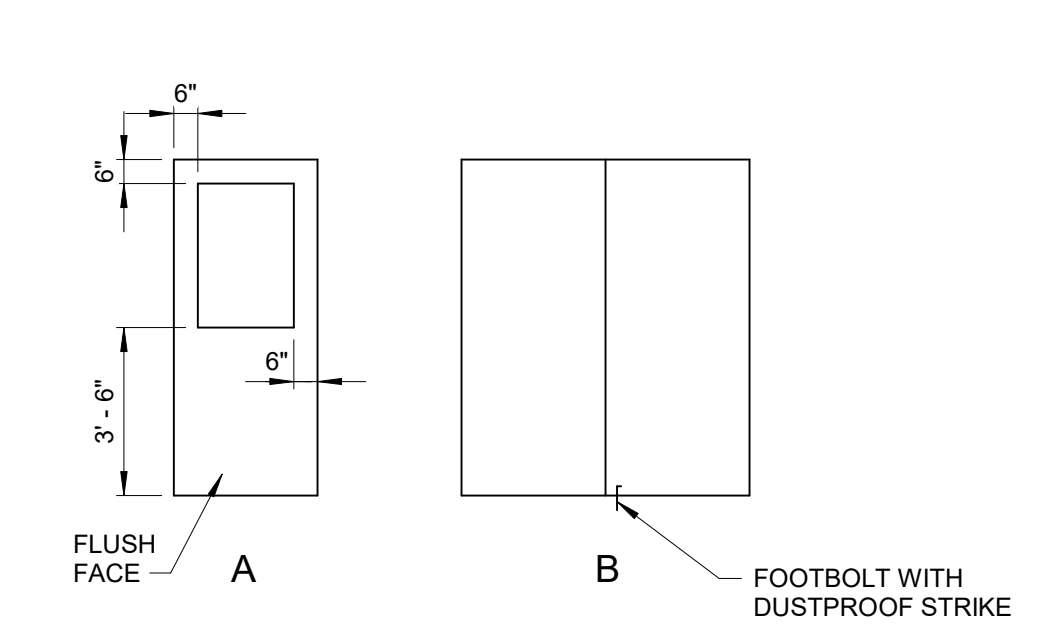
DOOR 5

PHOTO 5  
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FRAME TYPES 1/4" = 1'-0"

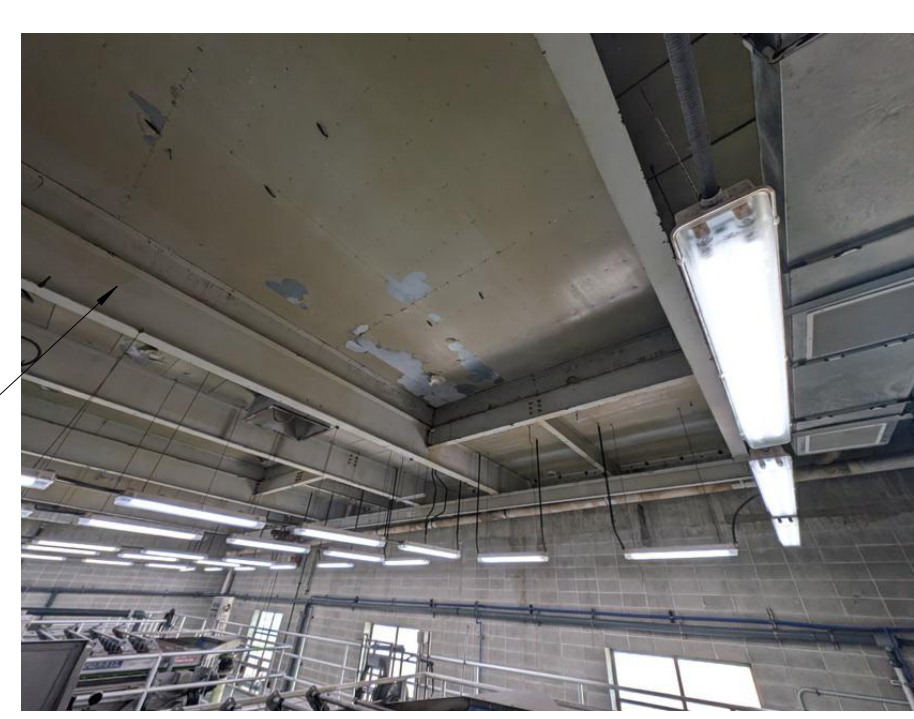


DOOR TYPES 1/4" = 1'-0"



PRESS ROOM

PHOTO 6  
NO SCALE S003



PRESS ROOM

PHOTO 7  
NO SCALE S003



SECOND FLOOR CONVEYOR

PHOTO 8  
NO SCALE S003



PUMP ROOM

PHOTO 9  
NO SCALE S002



TRUCK BAY

PHOTO 10  
NO SCALE S002

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<table border="1"> <tr> <td>1</td> <td>BID SET</td> <td>10/2024</td> <td>CNT</td> </tr> <tr> <td>REV</td> <td>ISSUED FOR</td> <td>DATE</td> <td>BY</td> </tr> </table>	1	BID SET	10/2024	CNT	REV	ISSUED FOR	DATE	BY	<p>PROJECT ENGINEER: C. THUNHORST</p> <p>DESIGNED BY: S. INGRAM</p> <p>DRAWN BY: J. BERG</p> <p>CHECKED BY: C. THUNHORST</p> <p>IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE</p> <p>0 1/2" 1"</p>	<p>10/17/24</p>	<p><b>Hazen</b></p> <p>HAZEN AND SAWYER 10619 SOUTH JORDAN GATEWAY, SUITE 130, SOUTH JORDAN, UT 84095</p>	<p>CENTRAL WEBER SEWER IMPROVEMENT DISTRICT OGDEN, UT</p> <p>DEWATERING BUILDING HVAC IMPROVEMENTS</p>	<p>STRUCTURAL DOORS AND PAINTING DETAILS</p>	<p>DATE: OCTOBER 2024</p> <p>HAZEN NO.: 70123-000</p> <p>CONTRACT NO.: 1</p> <p>DRAWING NUMBER: S006</p>
	1	BID SET	10/2024	CNT										
	REV	ISSUED FOR	DATE	BY										



**CMU OPENING REINFORCEMENT SCHEDULE**

"W" OPNG WIDTH	LINTEL DEPTH	LINTEL STIRRUP	"A" BAR LINTEL	"B" BAR JAMB	"J" MIN JAMB WIDTH
UP TO 2'-8"	8"	-	#5 BAR	1-#5 BAR EA JAMB	8"
>2'-8" ≤ 4'-0"	8"	-	2-#5 BARS	1-#5 BAR EA JAMB	8"
>4'-0" ≤ 6'-0"	16"	#3@8"	2-#5 BARS	2-#5 BAR EA JAMB	16"
>6'-0" ≤ 8'-0"	24"	#3@8"	2-#5 BARS	2-#5 BAR EA JAMB	16"
>8'-0"	SEE DRAWINGS				

NOTES TO ENGINEER (S-05-0102):  
 DETAIL MAY BE USED FOR CARBON STEEL OR STAINLESS STEEL FRAMING, BUT CAPACITY FOR STAINLESS STEEL CONNECTIONS MUST BE CHECKED. LISTED CAPACITIES ARE ONLY APPLICABLE FOR CARBON STEEL.  
 SHEAR CONNECTIONS PER AISC STEEL CONSTRUCTION MANUAL 14TH EDITION DESIGN TABLES 10-1, 10-2, AND 10-10a; CHECK DESIGN TABLE DISCUSSIONS BEFORE MAKING ANY CHANGES. LISTED CAPACITIES ARE CONSERVATIVE LOWER BOUND SHEARS FOR W SHAPES ONLY BASED ON THE FOLLOWING ASSUMPTIONS:  
 ALL 3/4" BOLTS ARE GROUP A THREAD CONDITION N AND STD HOLE TYPE CONNECTED BEAM IS COPED TOP AND BOTTOM THICKNESS OF SUPPORT STEEL IS AT LEAST 0.25" WEB THICKNESS OF CONNECTED BEAM IS SMALLEST TW FOR W SHAPES OF GIVEN DEPTH

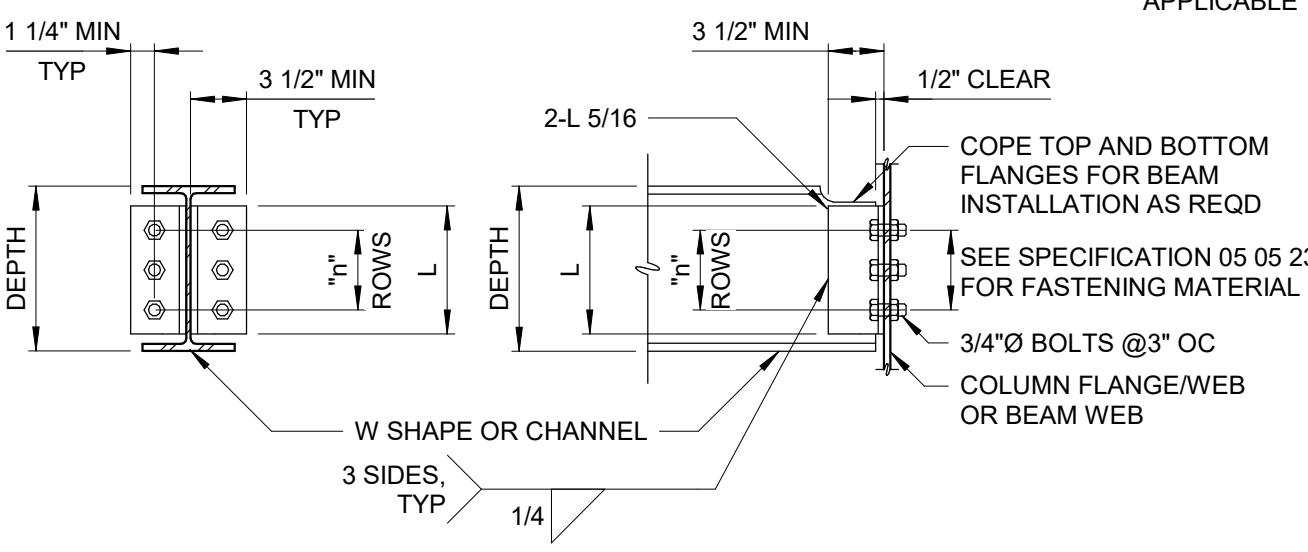
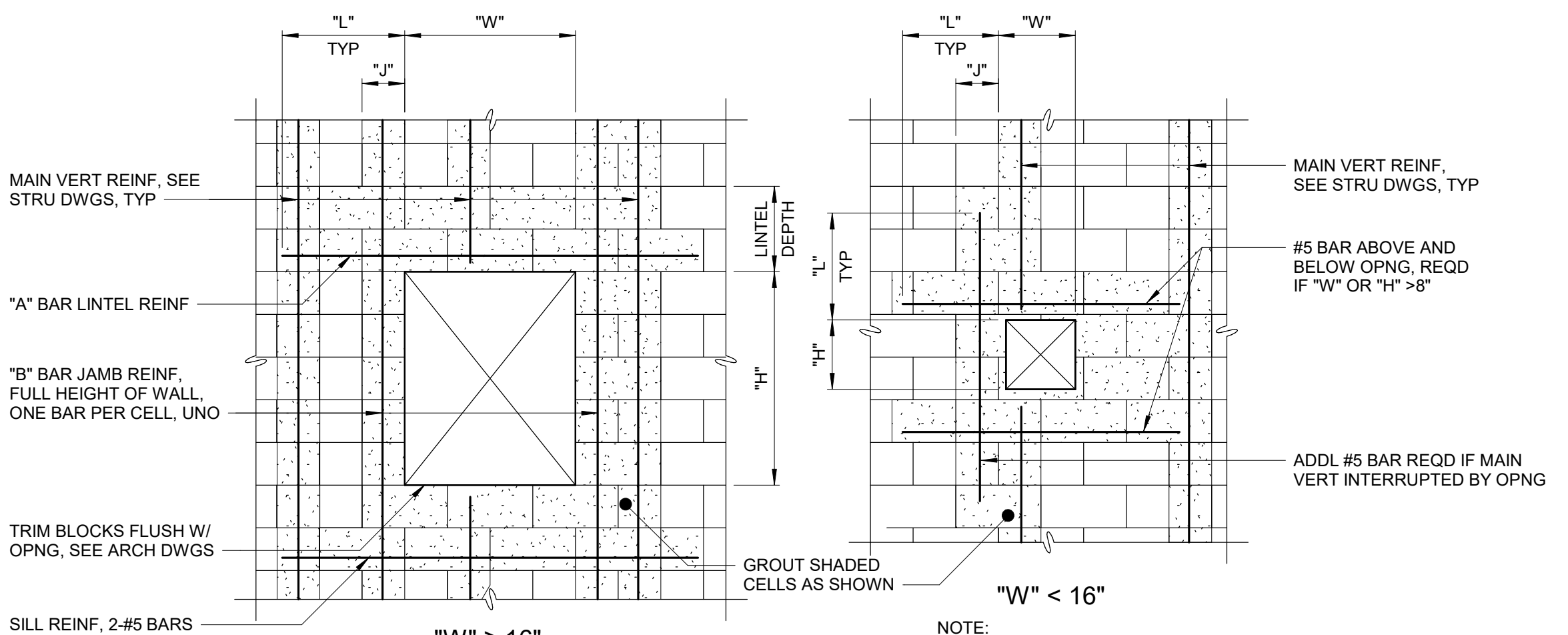
AISC TABLE 10-1 DOES NOT CONSIDER LIMIT STATES OF FLEXURAL YIELDING AND LOCAL BUCKLING OF THE BEAM WEB FOR COPE MEMBERS. SEE AISC PART 9. PER AISC, BEAMS WITH SHORT COPE NO GREATER THAN THE LENGTH OF CONNECTION ANGLES OR PLATES GENERALLY ARE NOT SUSCEPTIBLE TO FLEXURAL LOCAL WEB BUCKLING.

W SHAPE LOWER BOUND CAPACITY (KIPS) SEE NOTES TO ENGINEER

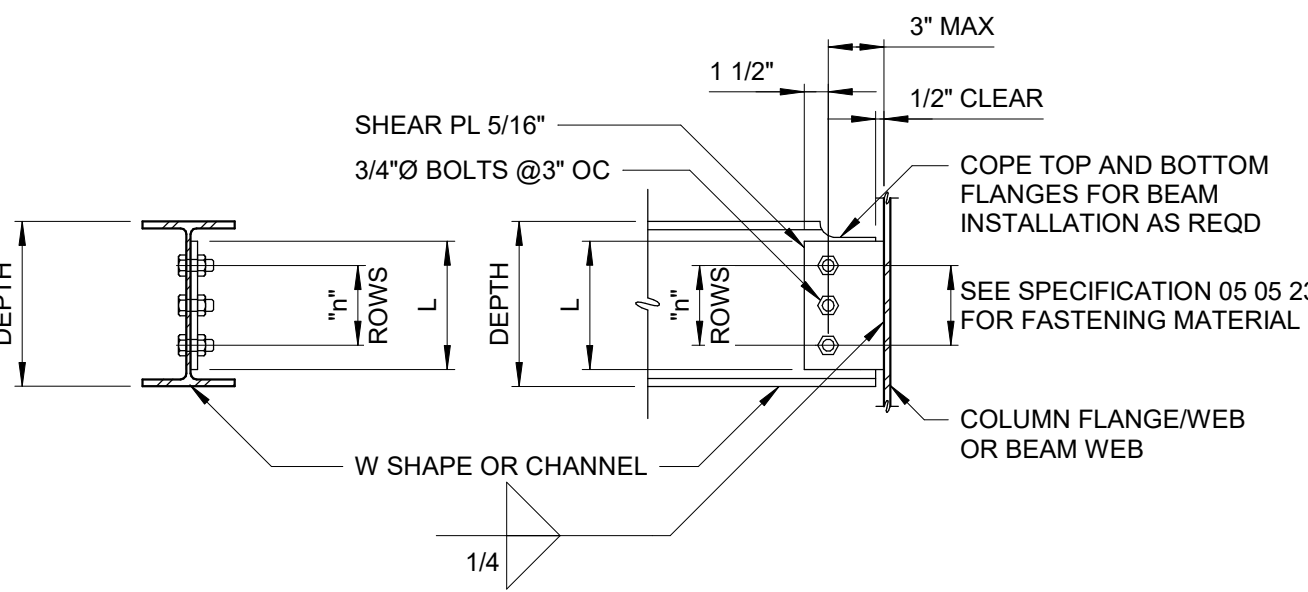
DOUBLE ANGLE		SINGLE PLATE	
ASD	LRFD	ASD	LRFD
12.4	18.7	12.4	18.7
23.0	34.4	23.0	34.4
39.0	58.5	39.0	58.5
69.0	103.6	64.1	81.3
94.4	141.4	59.3	89.1
128.8	193.2	72.1	108.0
151.3	227.0	84.7	127.0
185.0	278.0	94.8	142.0
205.0	308.0	105.0	157.0

NOTE: CHART NOT APPLICABLE TO CHANNELS

NOMINAL BEAM DEPTH	(n) ROWS	L
8"-10"	2	5 1/2"
12"-15"	3	8 1/2"
16"-18"	4	11 1/2"
21"	5	1'-2 1/2"
24"	6	1'-5 1/2"
27"	7	1'-8 1/2"
30"	8	1'-11 1/2"
33"	9	2'-2 1/2"
36"	10	2'-5 1/2"



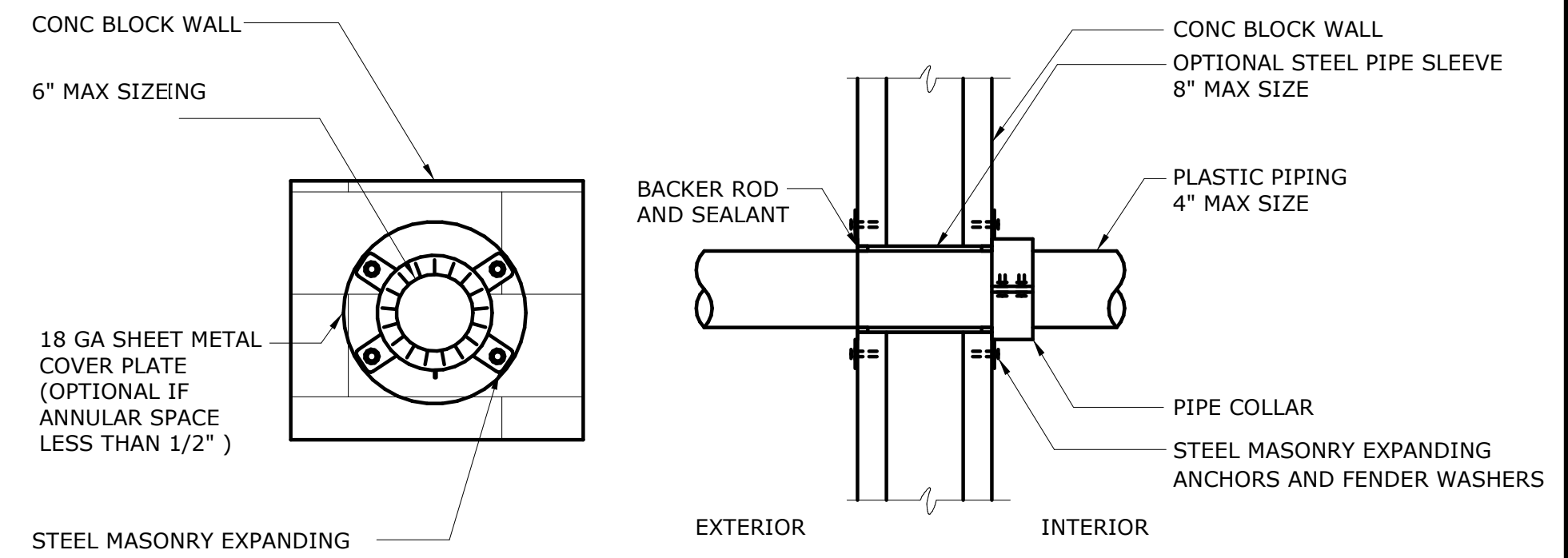
**TYPE I DOUBLE ANGLE**



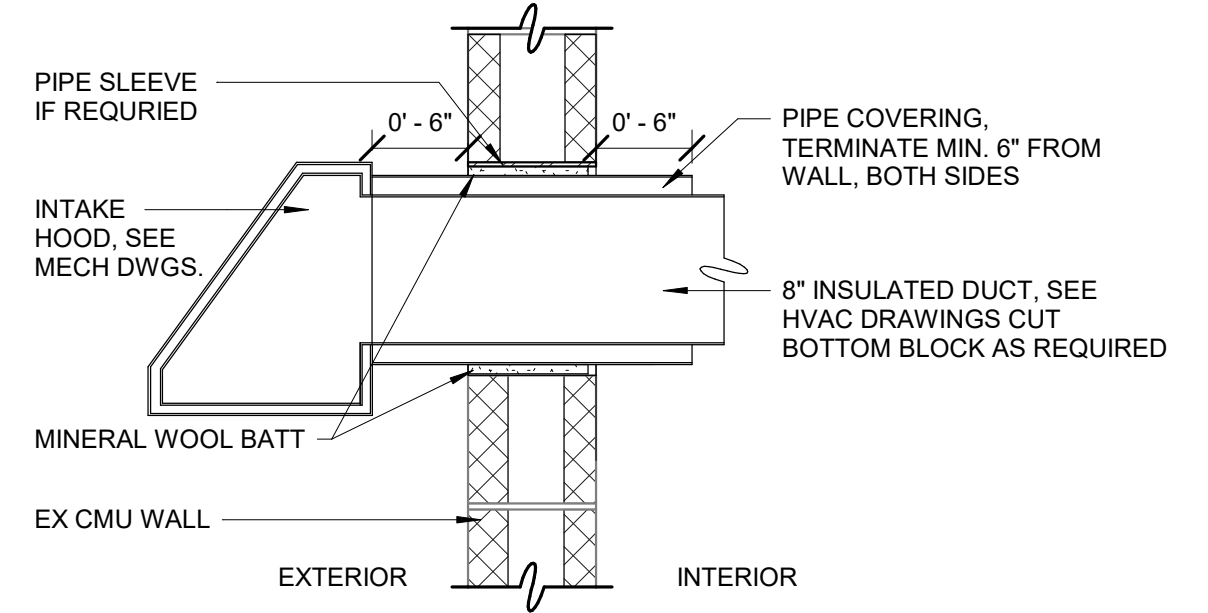
**TYPE II SINGLE PLATE**

NOTE: TYPE I DOUBLE ANGLE CONNECTION SHALL BE USED UNO ON DRAWINGS.

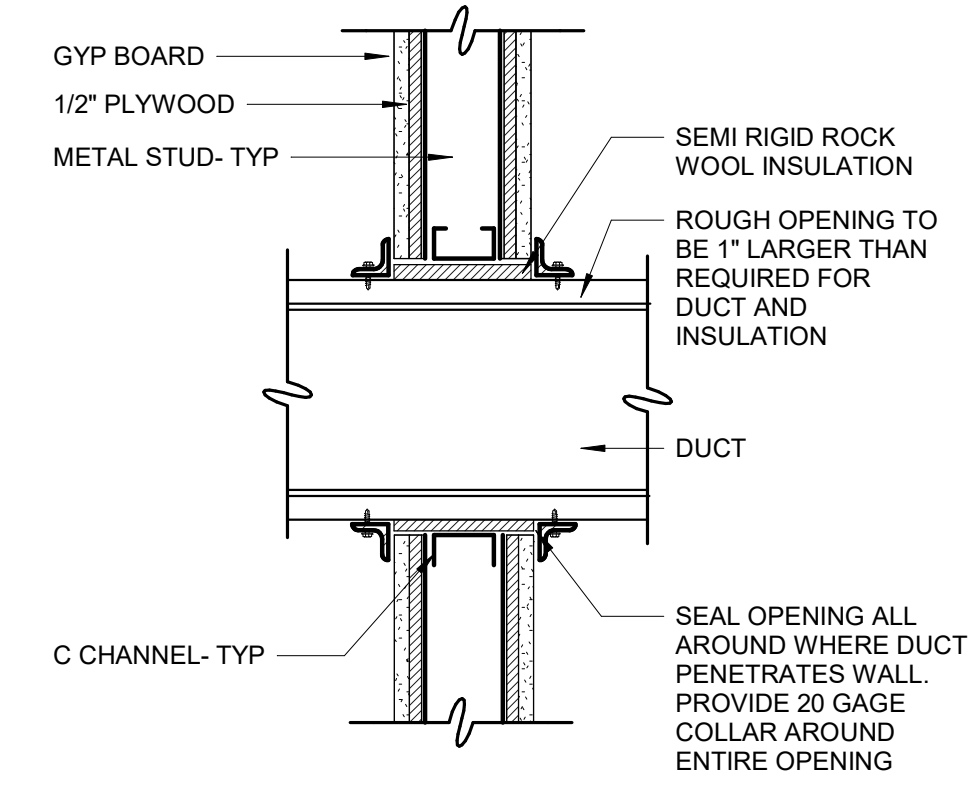
**STEEL FRAMING CONNECTION S-05-0102**



**PLASTIC PIPE THROUGH CMU WALL C-AJ-2110**



**EXHAUST METALLIC PIPE THROUGH CMU WALL C-AJ-5062**



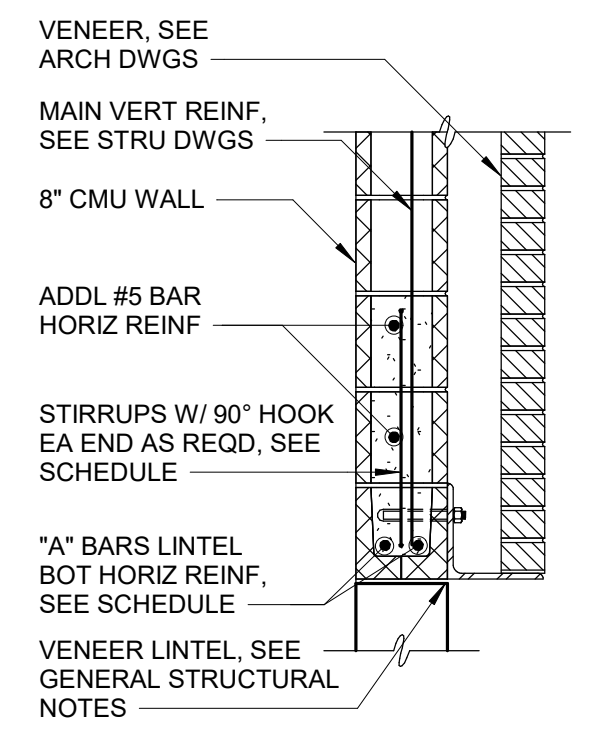
**DUCT THROUGH BUILDING WALL C-AJ-5063**

NOTE: "L" = 25" FOR #4 AND #5 BARS  
 "L" = 30 INCHES FOR #6 BARS

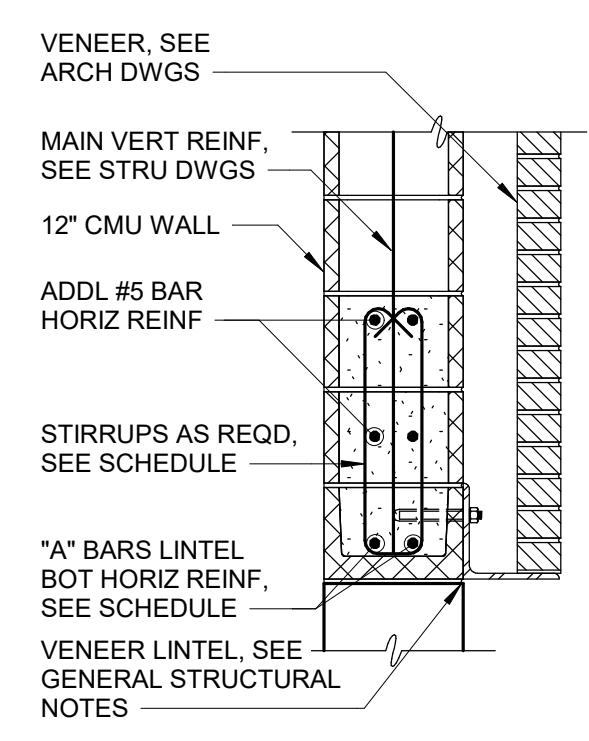
NOTE: "L" = 25" FOR #4 AND #5 BARS  
 "L" = 30 INCHES FOR #6 BARS

NOTE TO ENGINEER: (S-04-0202)

CMU LINTEL DESIGN UTILIZES ARCHING ACTION. WHERE ARCHING ACTION CANNOT OCCUR, ENGINEER SHALL CHECK CMU LINTEL CAPACITY. VENEER LINTEL ANCHORING INTO 8" CMU HAS LIMITED CAPACITY. 8" CMU LINTEL MAY NEED TO BE INCREASED TO 16" CMU LINTEL IF ADDITIONAL VENEER LINTEL CAPACITY IS REQUIRED.

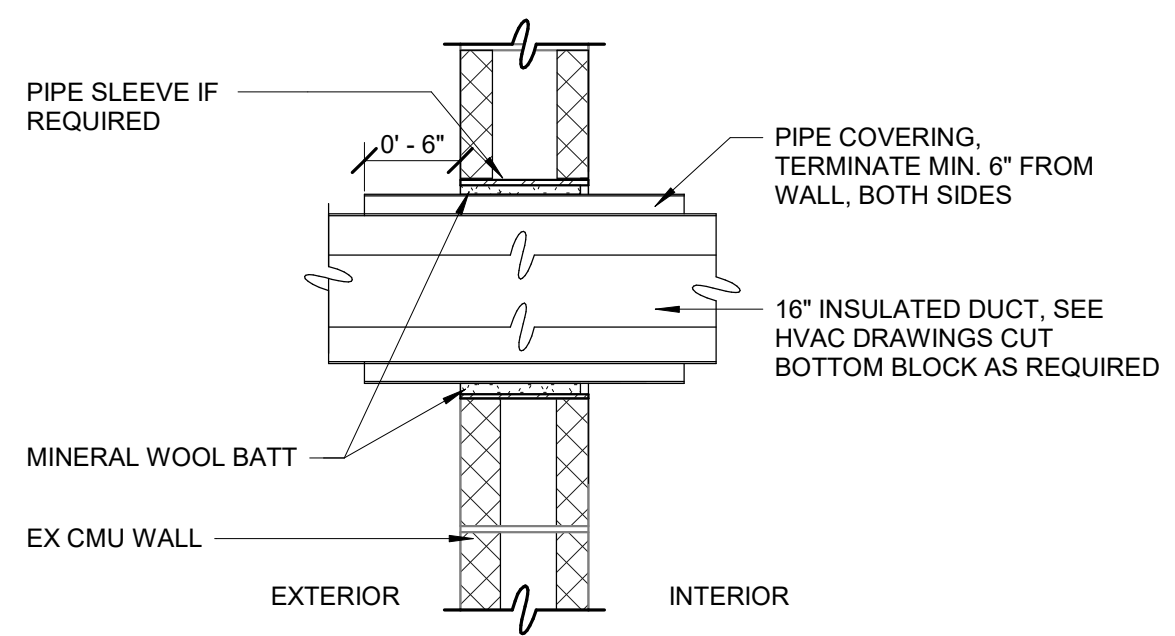


**8" LINTEL SECTION**



**12" LINTEL SECTION**

**TYPICAL MASONRY OPENINGS S-04-0202**



**METALLIC PIPE THROUGH CMU WALL SIGN C-AJ-5061**

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1	BID SET	10/2024	CNT	

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	S. INGRAM
DRAWN BY:	J. BERG
CHECKED BY:	C. THUNHORST

BID SET



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**CENTRAL WEBER  
 SEWER IMPROVEMENT DISTRICT  
 OGDEN, UT**  
 DEWATERING BUILDING HVAC  
 IMPROVEMENTS

**STRUCTURAL  
 SECTIONS AND DETAILS**

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	S007





**ABBREVIATIONS**

AE ANALYSIS ELEMENT  
 AHU AIR HANDLING UNIT  
 AIC AMPERE INTERRUPTING CAPACITY  
 AIT ANALYSIS INDICATING TRANSMITTER  
 ANSI AMERICAN NATIONAL STANDARDS INSTITUTE  
 ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS  
 ASME AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
 AF AMPERE FRAME  
 AT AMPERE TRIP  
 ATS AUTOMATIC TRANSFER SWITCH  
 BC BYPASS CONTACTOR  
 BKR BREAKER  
 (L/V)CP (LOCAL/VENDOR) CONTROL PANEL  
 CPT CONTROL POWER TRANSFORMER  
 CT CURRENT TRANSFORMER  
 (D) DEMOLITION  
 DB DUCTBANK  
 DSW DISCONNECT SWITCH  
 (\*)HH HANDHOLE\*  
 (\*)MH MANHOLE\*  
 (E) EXISTING  
 EO ELECTRICALLY OPERATED  
 ETM ELAPSED TIME METER  
 ETU ELECTRONIC TRIP UNIT  
 (F) FUTURE  
 FAAP FIRE ALARM ANNUNCIATOR PANEL  
 FACP FIRE ALARM CONTROL PANEL  
 FS FLOW SWITCH  
 FSL FLOW SWITCH LOW  
 FVNR FULL VOLTAGE NON-REVERSING  
 FVR FULL VOLTAGE REVERSING  
 GFCl GROUND FAULT CIRCUIT INTERRUPTER  
 GFCT GROUND FAULT CURRENT TRANSFORMER  
 GNG GO-NO GO  
 GND GROUND  
 HOA HAND-OFF-AUTO  
 HH HANDHOLE  
 HPU HYDRAULIC POWER UNIT  
 IC INPUT CONTACTOR  
 IEEE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS  
 ISO INTERNATIONAL ORGANIZATION FOR STANDARDIZATION  
 (\*)JB JUNCTION BOX\*  
 LCS LOCAL CONTROL STATION  
 LP LIGHTING PANEL  
 LS LEVEL SWITCH  
 LSL LEVEL SWITCH LOW  
 LSLl LEVEL SWITCH LOW-LOW  
 LSH LEVEL SWITCH HIGH  
 LSHH LEVEL SWITCH HIGH-HIGH  
 LT LEVEL TRANSMITTER  
 MFR MULTI-FUNCTION RELAY  
 MH MANHOLE  
 MOD MOTOR OPERATED DAMPER  
 MOG MOTOR OPERATED GATE  
 MOL MOTOR OPERATED LOUVER  
 MOV MOTOR OPERATED VALVE  
 MPR MOTOR PROTECTION RELAY  
 MTD MOUNTED  
 MTS MANUAL TRANSFER SWITCH  
 MWTS MOTOR WINDING TEMPERATURE SWITCH  
 (N) NEW  
 NC NORMALLY CLOSED  
 NEC NATIONAL ELECTRICAL CODE  
 NEMA NATIONAL ELECTRICAL MANUFACTURERS ASSN  
 NFPA NATIONAL FIRE PROTECTION ASSOCIATION  
 NO NORMALLY OPEN  
 NTS NOT TO SCALE  
 OC OUTPUT CONTACTOR  
 OL OVERLOAD

**ABBREVIATIONS, CONT.**

(\*)PB PULLBOX\*  
 PC PHOTOCELL  
 PCC POINT OF COMMON COUPLING  
 PE PRESSURE ELEMENT  
 PIT PRESSURE INDICATING TRANSMITTER  
 PLC PROGRAMMABLE LOGIC CONTROLLER  
 PP POWER PANEL  
 PST PHASE SHIFTING TRANSFORMER  
 PT POTENTIAL TRANSFORMER  
 PTT PUSH TO TEST  
 RCS REMOTE CONTROL STATION  
 RECP RECEPTACLE  
 RIO REMOTE I/O  
 RM ROOM  
 RTD RESISTANCE THERMAL DEVICE  
 RTU REMOTE TELEMETRY UNIT  
 RVAT REDUCED VOLTAGE AUTO TRANSFORMER  
 RVSS REDUCED VOLTAGE SOLID STATE STARTER  
 SA SUPPLY AIR  
 S.E. SERVICE ENTRANCE  
 SP. C. SPARE CONDUIT  
 SPD SURGE PROTECTIVE DEVICE  
 SSOL SOLID STATE OVERLOAD  
 SST STAINLESS STEEL  
 TB TEST BLOCK  
 TC TIMED CLOSE  
 TO TIMED OPEN  
 TSH TWISTED SHIELDED  
 TS TRANSFORMER  
 TYP TYPICAL  
 UPS UNINTERRUPTIBLE POWER SUPPLY  
 VFD VARIABLE FREQUENCY DRIVE  
 WPCR WEATHER PROOF CORROSION RESISTANT  
 WT WALK THROUGH  
 XFMR TRANSFORMER

\*DESIGNATED ABBREVIATIONS CAN HAVE THE FOLLOWING PREFIXES:

E ELECTRIC  
 P POWER  
 C CONTROL  
 I INSTRUMENTATION  
 F FIBER

**GENERAL NOTES:**

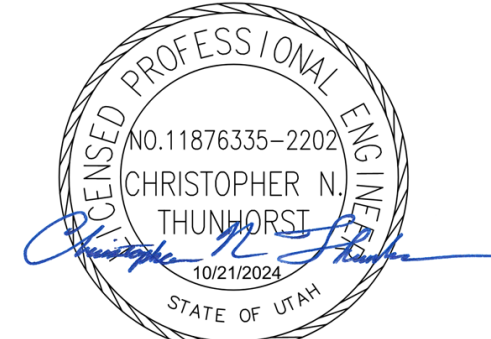
- UNLESS OTHERWISE SPECIFIED OR NOTED, ALL WALL MOUNTED ELECTRICAL PANELS, ENCLOSURES, AND SIMILAR EQUIPMENT SHALL BE MOUNTED 6'-6" (MAX) FROM THE TOP OF THE PANEL TO FINISHED FLOOR OR GRADE.
- UNLESS OTHERWISE NOTED, ALL LIGHTING SWITCHES, CONTROL SWITCHES, AND SIMILAR EQUIPMENT SHALL BE MOUNTED WITH THEIR CENTERLINE APPROXIMATELY 4'-0" ABOVE FINISHED FLOOR, SLAB, OR GRADE.
- A SEPARATE EQUIPMENT GROUNDING CONDUCTOR SHALL BE PROVIDED FOR EACH CIRCUIT (SEPARATE CONDUCTOR IN THE CONDUIT). THE CONDUCTOR SHALL BE TERMINATED AT THE PROPER DEVICE, TERMINAL, OR LUG AT THE POWER SOURCE (MCC GROUND BUS, PANELBOARD GROUND BUS, ETC.). GROUND CONDUCTOR SIZE SHALL BE PER THE LATEST EDITION OF THE NEC.
- FIRE ALARM SYSTEMS SHALL BE PROVIDED FOR THE DEWATERING BUILDING AND IN ACCORDANCE WITH SECTION 28 46 20.
- REFERENCE SECTION 01 14 00 FOR CONSTRUCTION SEQUENCING REQUIREMENTS.
- CONDUIT HOMERUNS ARE NOT SHOWN ON THE DRAWINGS. CONTRACTOR SHALL REFER TO CONDUIT AND WIRE SCHEDULES, RISER DIAGRAMS, SINGLE LINE DIAGRAMS, AND OTHER DRAWINGS FOR CONDUIT AND WIRE REQUIREMENTS.

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1	BID SET	10/2024	CNT
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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET



**Hazen**  
 HAZEN AND SAWYER  
 10619 SOUTH JORDAN GATEWAY,  
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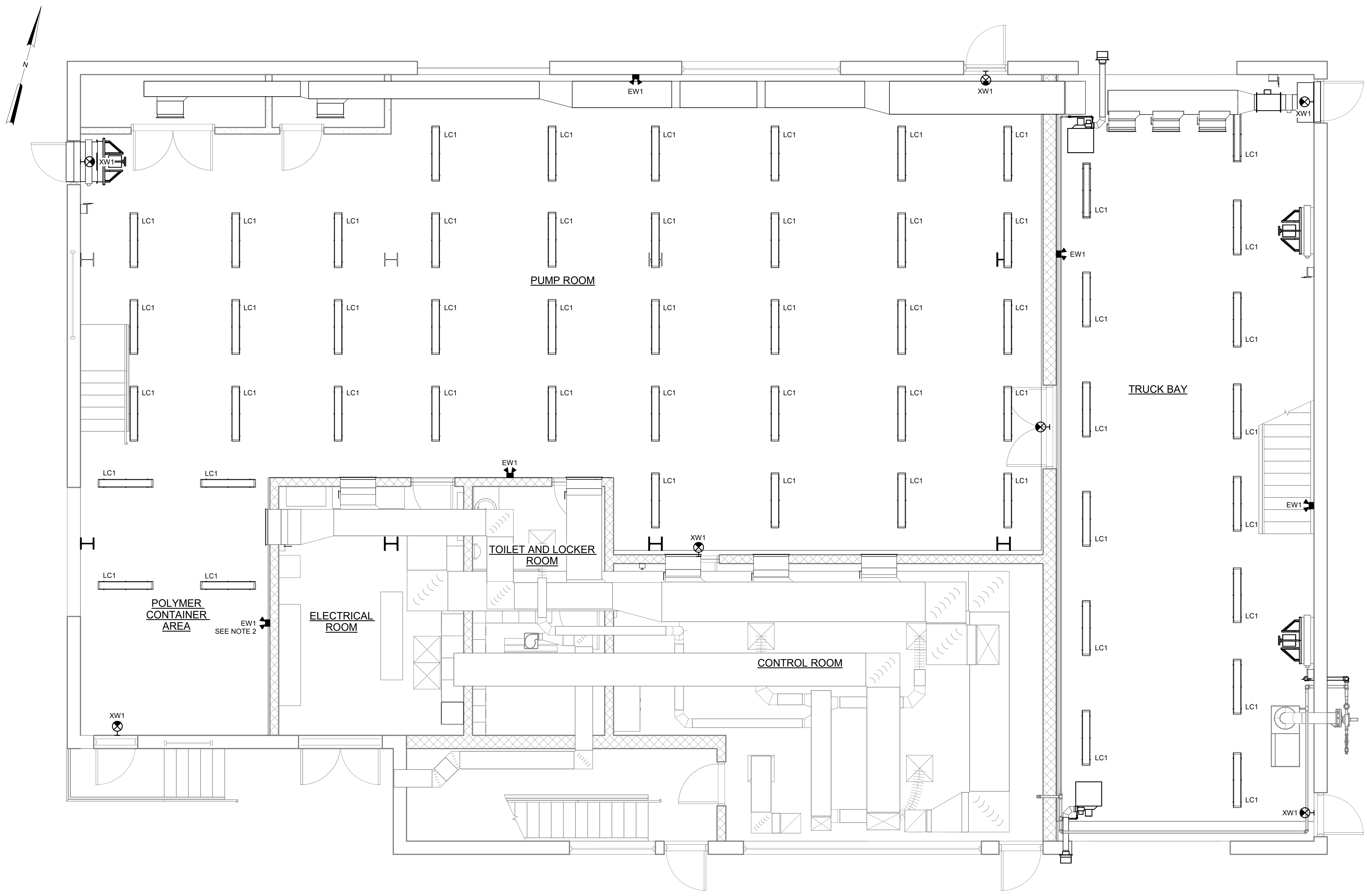
CENTRAL WEBER  
 SEWER IMPROVEMENT DISTRICT  
 OGDEN, UT  
 DEWATERING BUILDING HVAC  
 IMPROVEMENTS

ELECTRICAL  
 GENERAL NOTES AND ABBREVIATIONS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E002



- NOTES:**
1. REPLACE EXISTING LIGHT FIXTURES WITH NEW FIXTURES SHOWN. UTILIZE EXISTING POWER AND SWITCHING CIRCUITS FOR NEW FIXTURES. ADJUST LOCATION OF LIGHT FIXTURES AS REQUIRED TO COORDINATE WITH NEW DUCTWORK.
  2. EXTEND WIRING TO CONNECT NEW EMERGENCY LIGHTING INTO EXISTING EMERGENCY CIRCUIT.



**FIRST FLOOR LIGHTING PLAN**  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
10/21/2024 10:29:49 AM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

0 1/2" 1"

**Hazen**

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

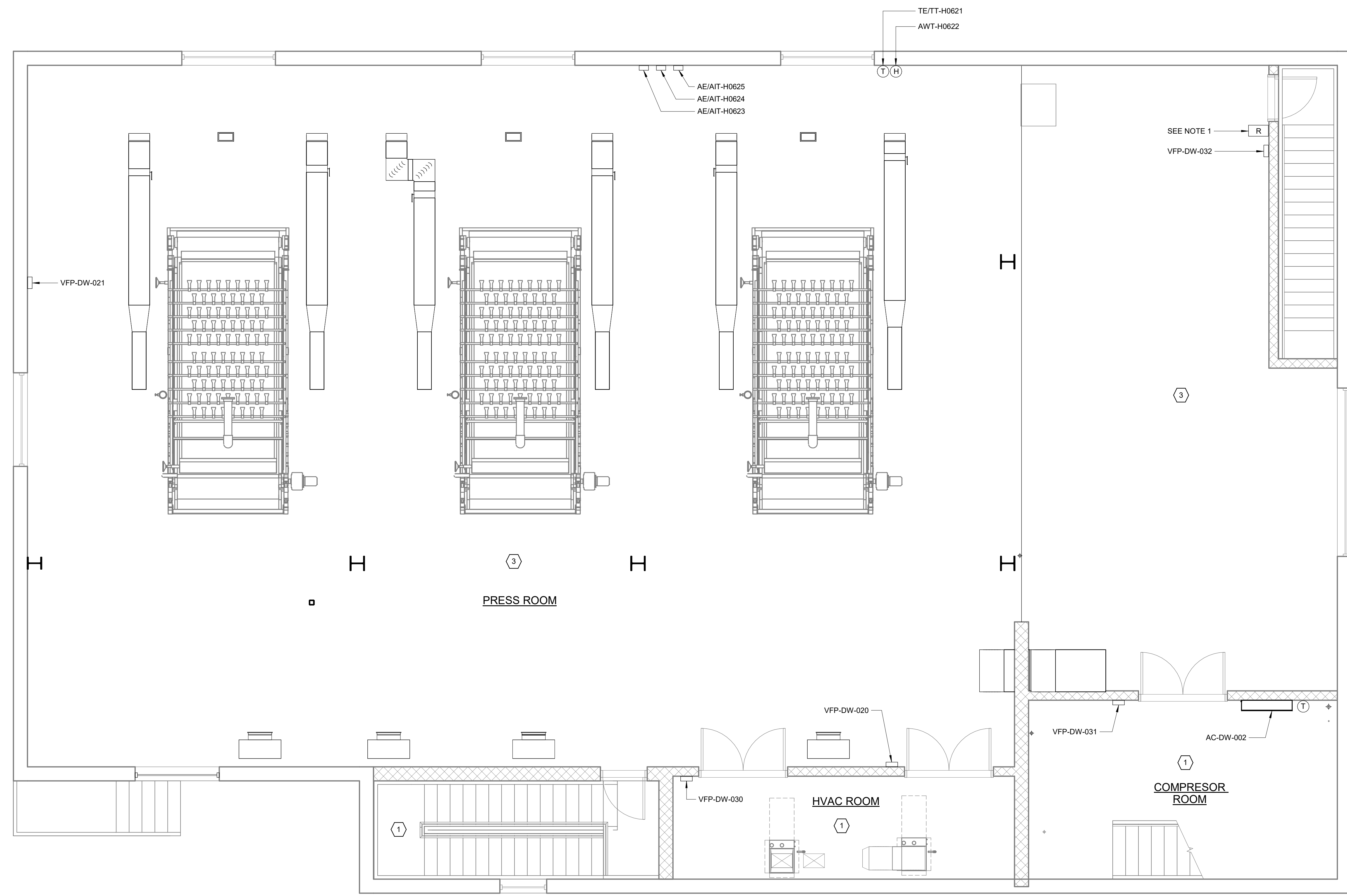
ELECTRICAL  
FIRST FLOOR LIGHTING PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E004



NOTES:  
 1. CONNECT ENCLOSED RELAY TO LIGHTING CIRCUIT. RELAY TO SEND SIGNAL TO RIO-DW-002 TO INDICATE OCCUPANCY.

- AREA DESIGNATIONS:
- ① INDOOR DRY NON-PROCESS AREA
  - ② INDOOR DRY PROCESS AREA
  - ③ INDOOR WET PROCESS AREA
  - ④ INDOOR WET NON-PROCESS AREA



SECOND FLOOR LOWER PLAN  
 1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
 10/21/2024 10:03:50 AM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET



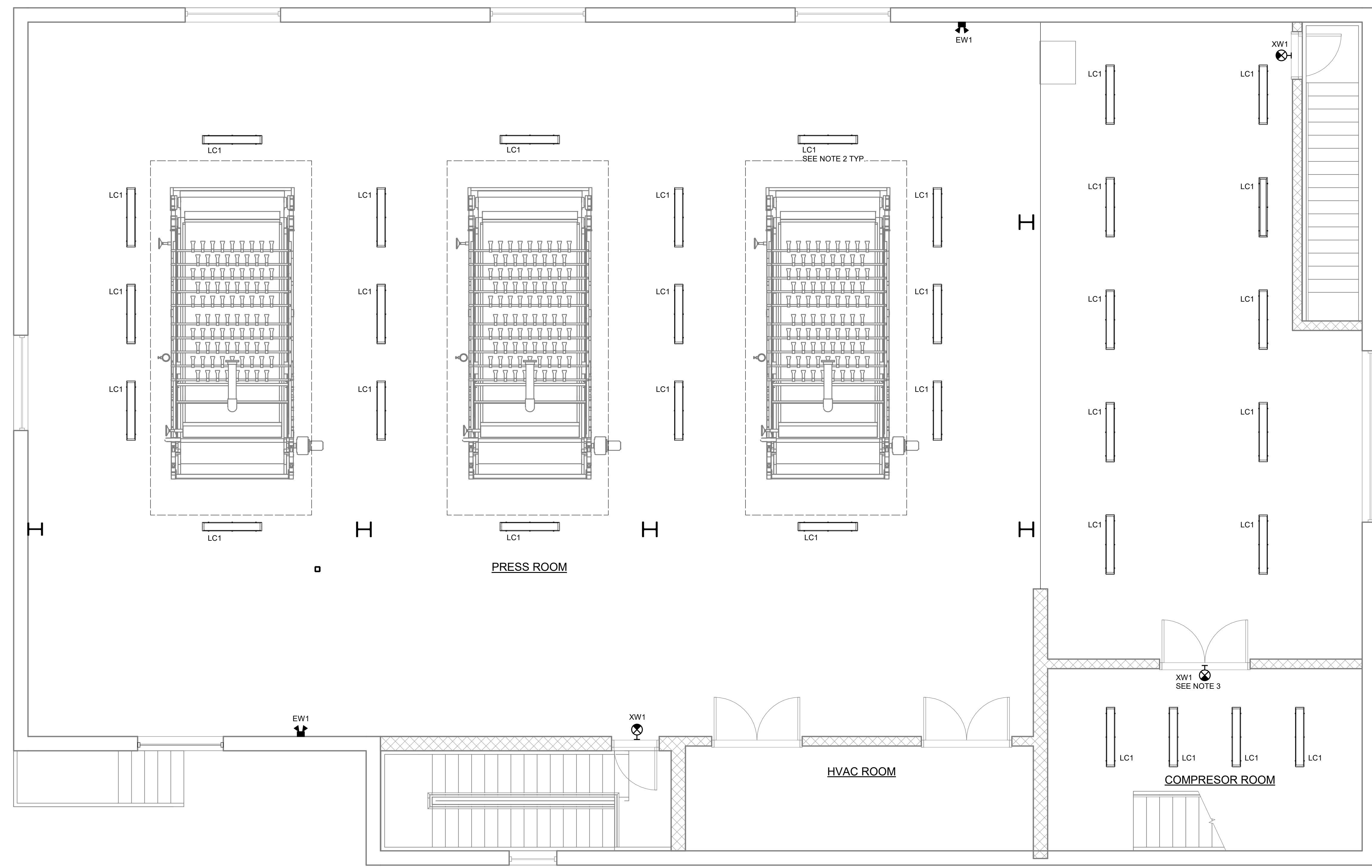
**Hazen**  
 HAZEN AND SAWYER  
 10619 SOUTH JORDAN GATEWAY,  
 SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
 SEWER IMPROVEMENT DISTRICT  
 OGDEN, UT  
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 IMPROVEMENTS

ELECTRICAL  
 SECOND FLOOR LOWER POWER AND CONTROLS  
 PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E005

- NOTES:**
1. REPLACE EXISTING LIGHT FIXTURES WITH NEW FIXTURES SHOWN. UTILIZE EXISTING POWER AND SWITCHING CIRCUITS FOR NEW FIXTURES. ADJUST LOCATION OF LIGHT FIXTURES AS REQUIRED TO COORDINATE WITH NEW DUCTWORK.
  2. LIGHT FIXTURES SHOWN AROUND PRESSES ARE MOUNTED TO THE BOTTOM OF EXISTING PLATFORM.
  3. THIS IS A NEW FIXTURE. EXTEND UN-SWITCHED LIGHTING CIRCUIT TO POWER NEW EXIT SIGN. FIELD COORDINATE EXACT REQUIREMENTS.



**SECOND FLOOR LOWER LIGHTING PLAN**  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
10/21/2024 10:03:51 AM

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"

BID SET



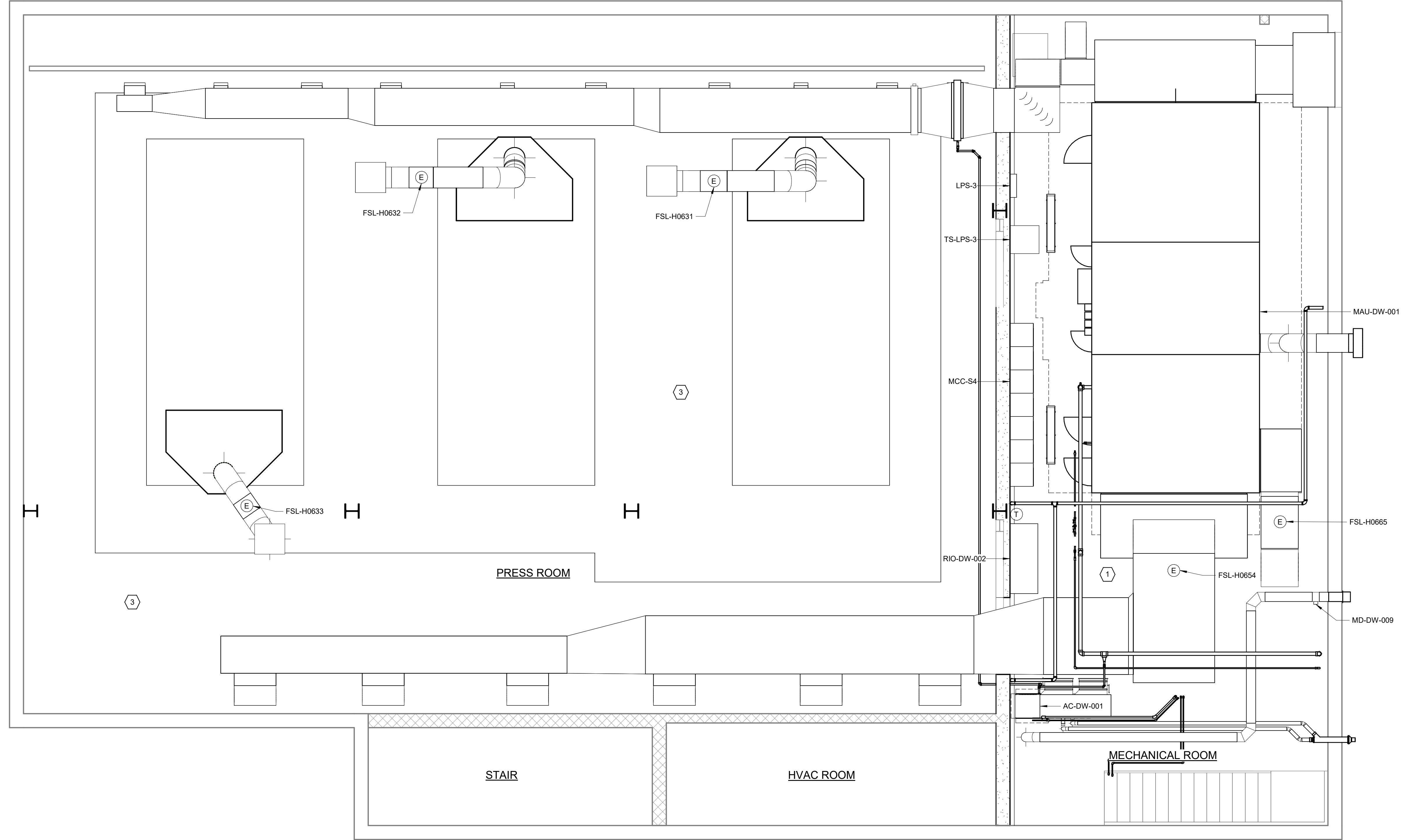
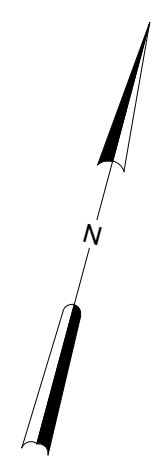
**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
SECOND FLOOR LOWER LIGHTING PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E006

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY



- AREA DESIGNATIONS:**
- ① INDOOR DRY NON-PROCESS AREA
  - ② INDOOR DRY PROCESS AREA
  - ③ INDOOR WET PROCESS AREA
  - ④ INDOOR WET NON-PROCESS AREA

**SECOND FLOOR UPPER PLAN / THIRD FLOOR PLAN**  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
10/21/2024 10:03:51 AM

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REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET



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HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

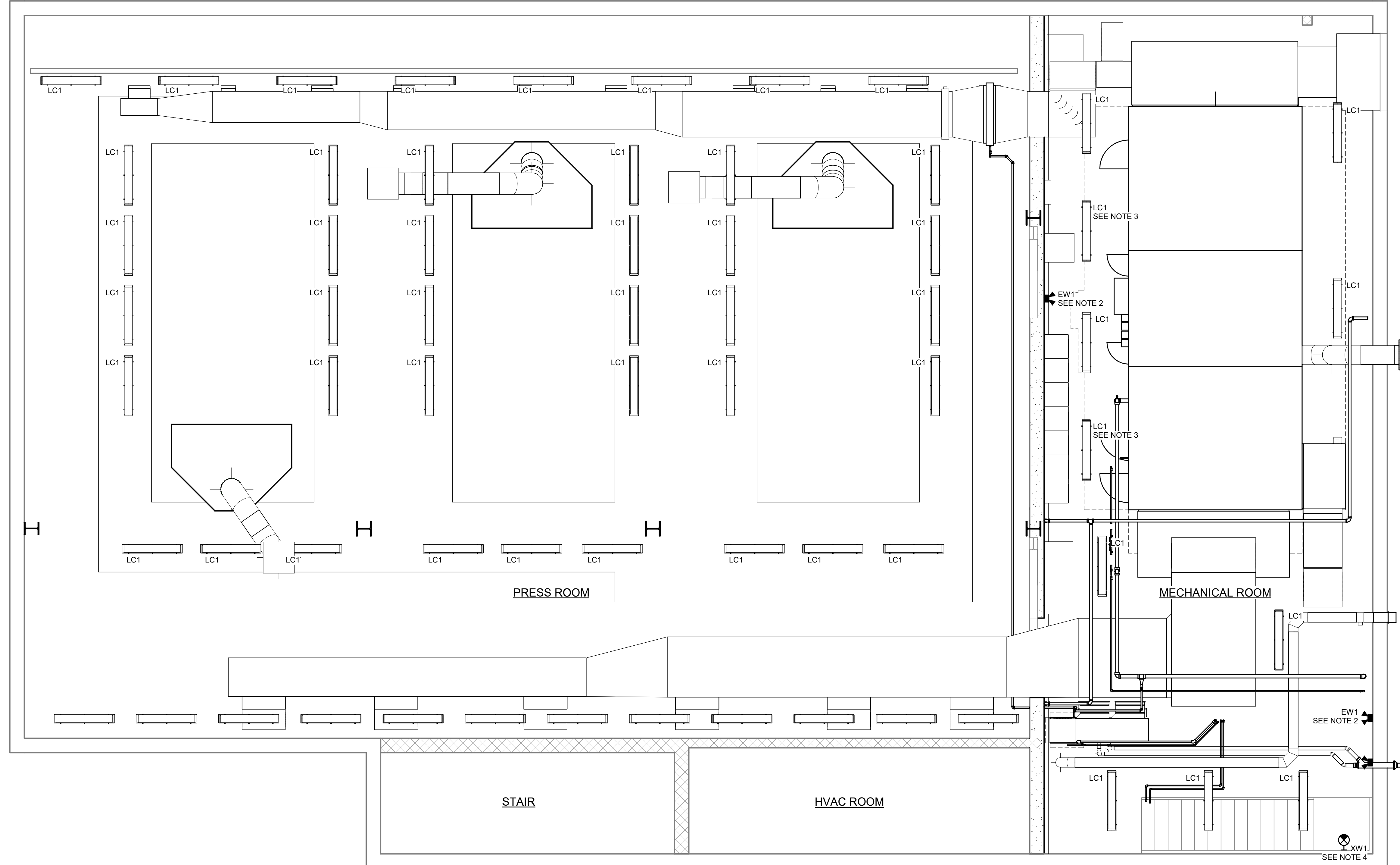
**CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT**

**DEWATERING BUILDING HVAC  
IMPROVEMENTS**

**ELECTRICAL  
SECOND FLOOR UPPER / THIRD FLOOR POWER AND  
CONTROLS PLAN**

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E007

- NOTES:
1. REPLACE EXISTING LIGHT FIXTURES WITH NEW FIXTURES SHOWN. UTILIZE EXISTING POWER AND SWITCHING CIRCUITS FOR NEW FIXTURES. ADJUST LOCATION OF LIGHT FIXTURES AS REQUIRED TO COORDINATE WITH NEW DUCTWORK.
  2. EXTEND WIRING TO CONNECT NEW EMERGENCY LIGHTING INTO EXISTING EMERGENCY CIRCUIT.
  3. INSTALL ADDITIONAL LIGHTING FIXTURES IN THIS AREA AS SHOWN. CONNECT ADDITIONAL LIGHT FIXTURES TO THE EXISTING POWER/SWITCH CIRCUITS.
  4. THIS IS A NEW FIXTURE. EXTEND EXISTING UN-SWITCHED LIGHTING CIRCUIT TO POWER NEW EXIT SIGN. FIELD COORDINATE EXACT REQUIREMENTS.



SECOND FLOOR UPPER PLAN / THIRD FLOOR LIGHTING PLAN  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
10/21/2024 10:03:52 AM

PROJECT ENGINEER:	C. THUNHORST
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BID SET



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SUITE 130, SOUTH JORDAN, UT 84095

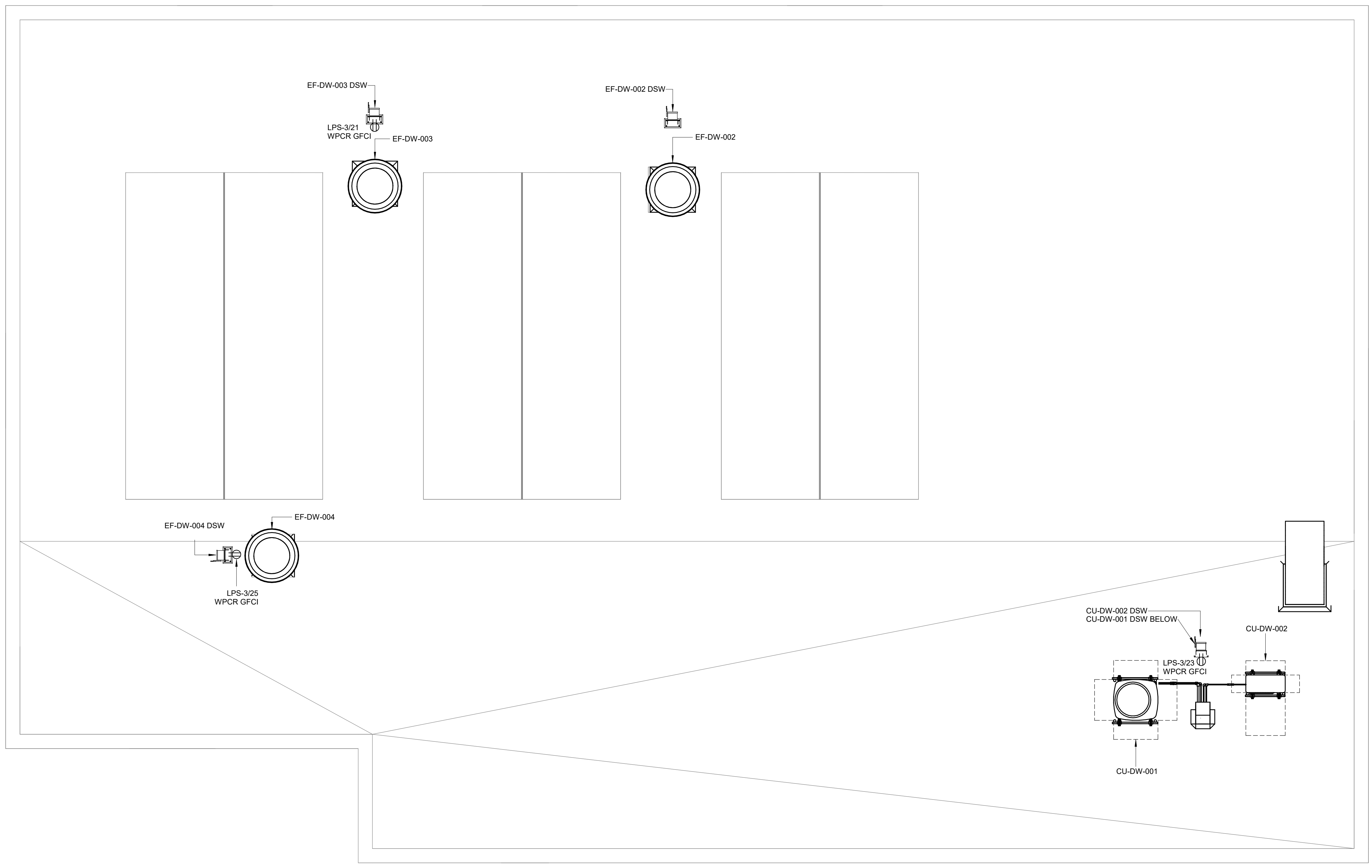
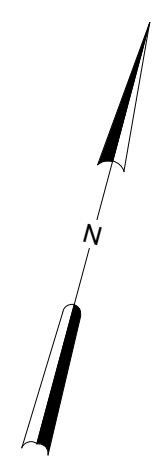
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
SECOND FLOOR UPPER / THIRD FLOOR LIGHTING  
PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E008

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY





ROOF PLAN  
1/4" = 1'-0"

Autodesk Docs/70123-000\_CNSID Dewatering Building HVAC Improv/70123-000-200-CNSID-E-14  
10/21/2024 10:03:52 AM

1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

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DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET

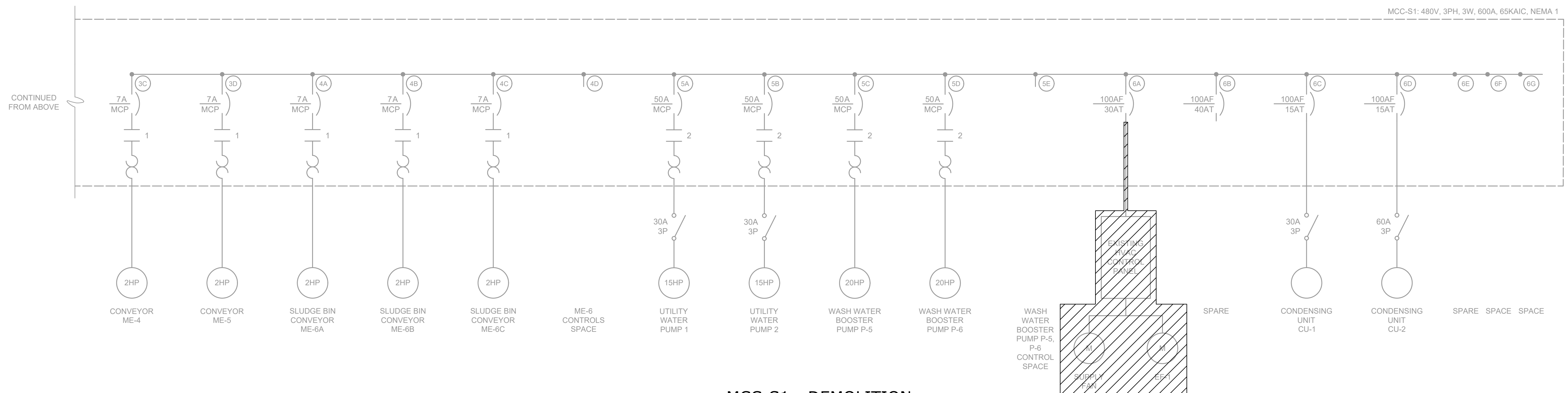
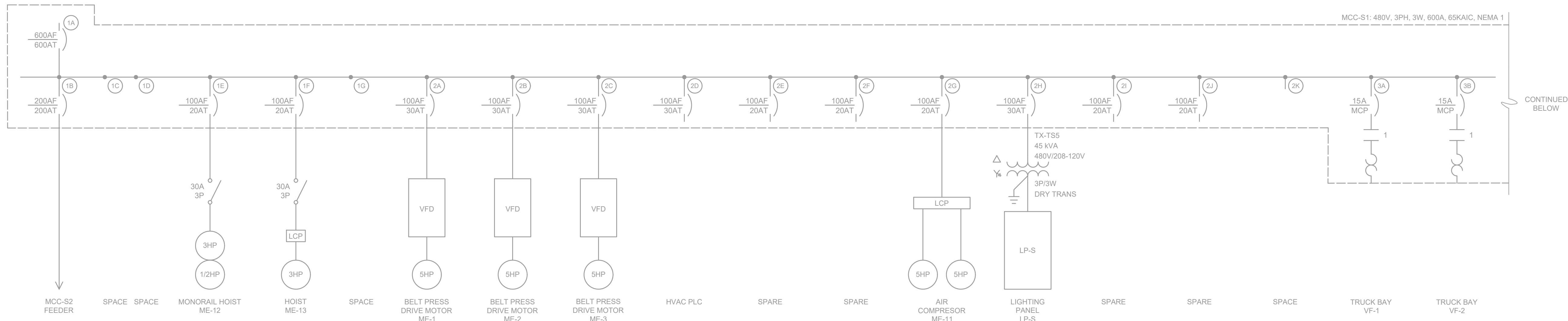


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HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
ROOF PLAN

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E009



**MCC-S1 - DEMOLITION**  
SINGLE LINE DIAGRAM

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
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IMPROVEMENTS

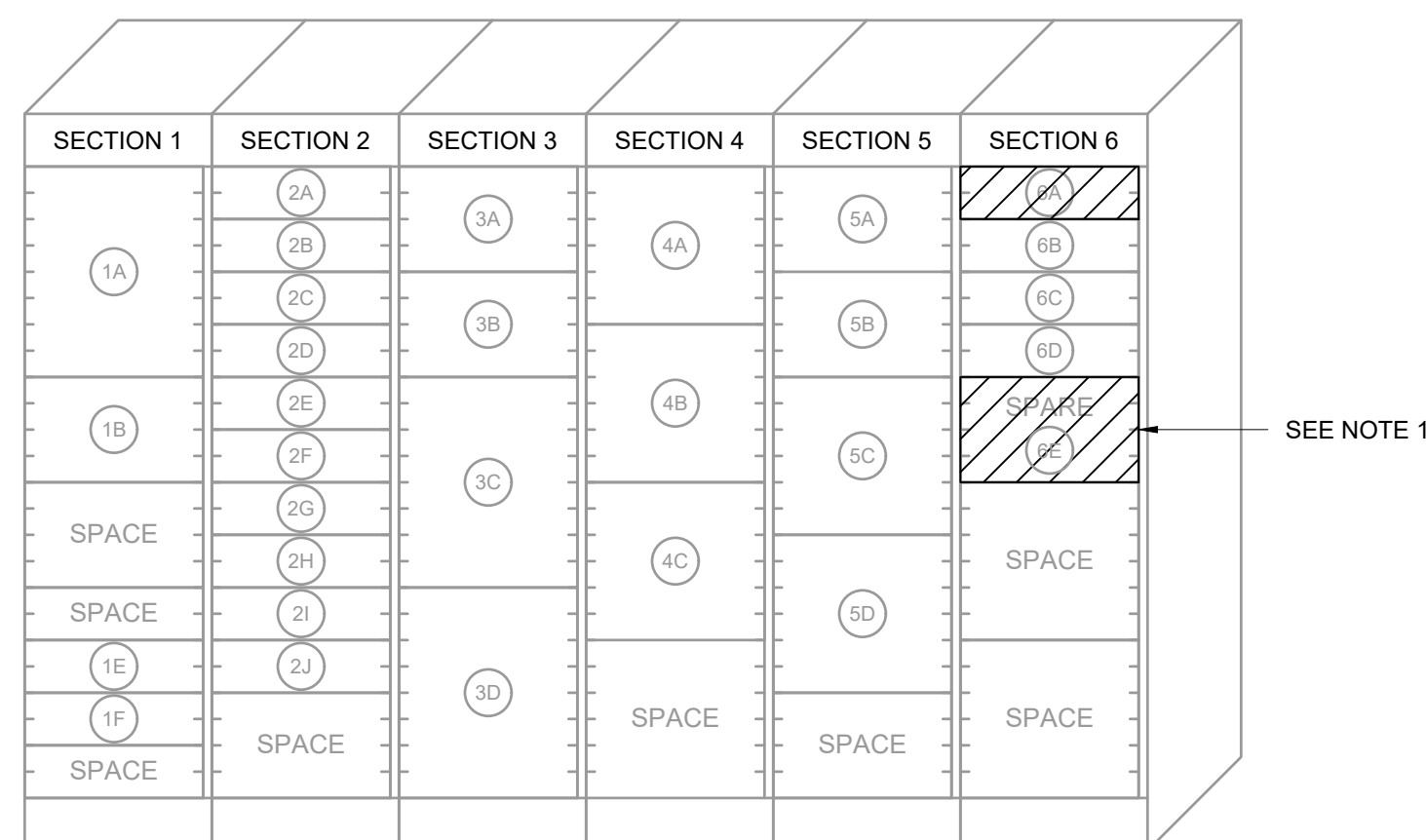
ELECTRICAL  
MCC-S1 SINGLE LINE DIAGRAM - DEMOLITION

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E010

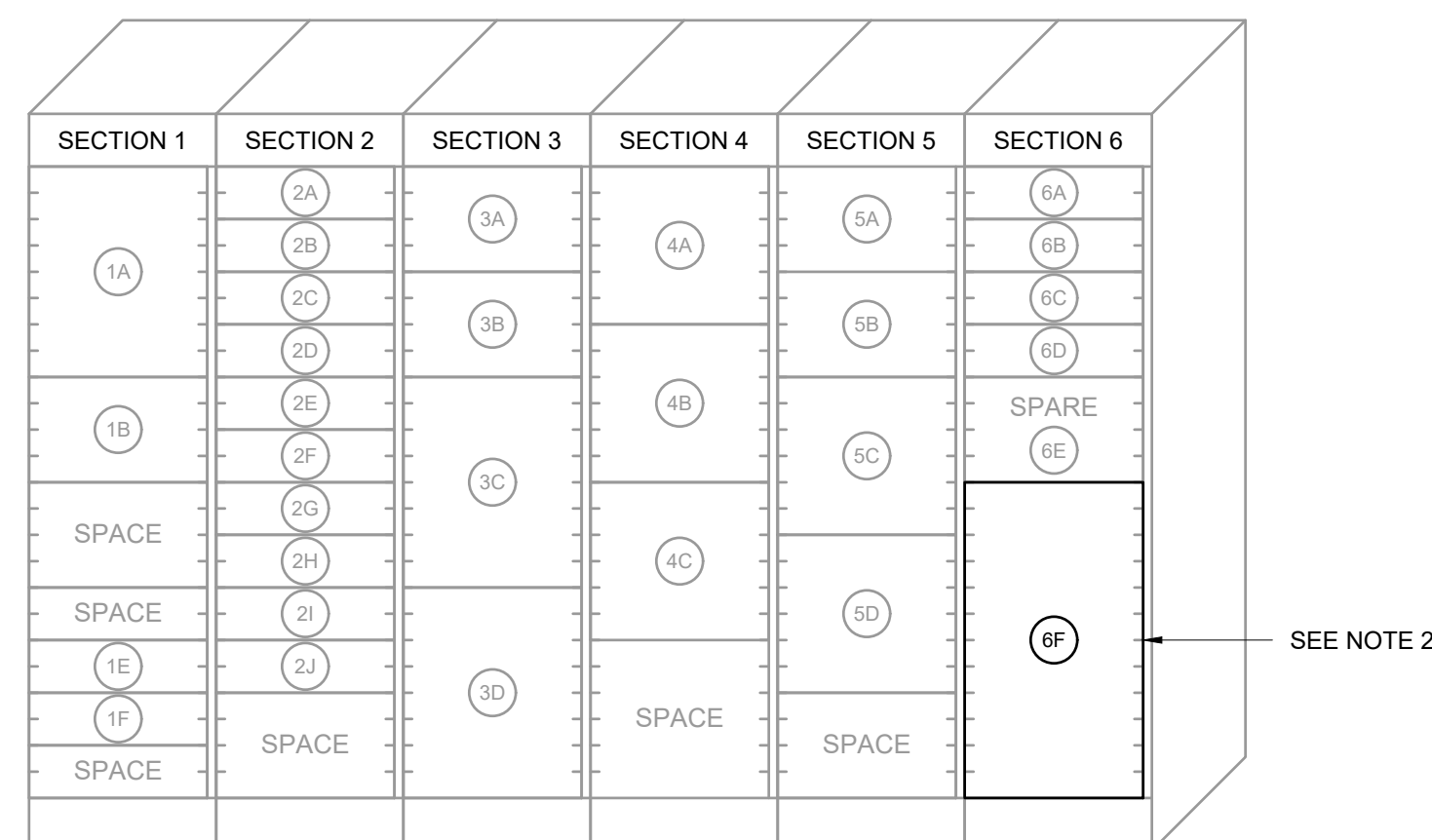


**NOTES:**

1. REMOVE SPARE BUCKET (6E) IF REQUIRED TO MAKE SPACE FOR NEW BREAKER.
2. INSTALL NEW CIRCUIT BREAKER IN EXISTING SPACE TO POWER NEW MCC-S4.



**MCC-S1 DEMOLITION**  
ELEVATION



**MCC-S1 MODIFIED**  
ELEVATION

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PLOT DATE: 10/21/2024 9:53 AM BY: ETOLED0

1	BID SET	10/2024	CNT
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PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
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CHECKED BY:	C. THUNHORST

BID SET

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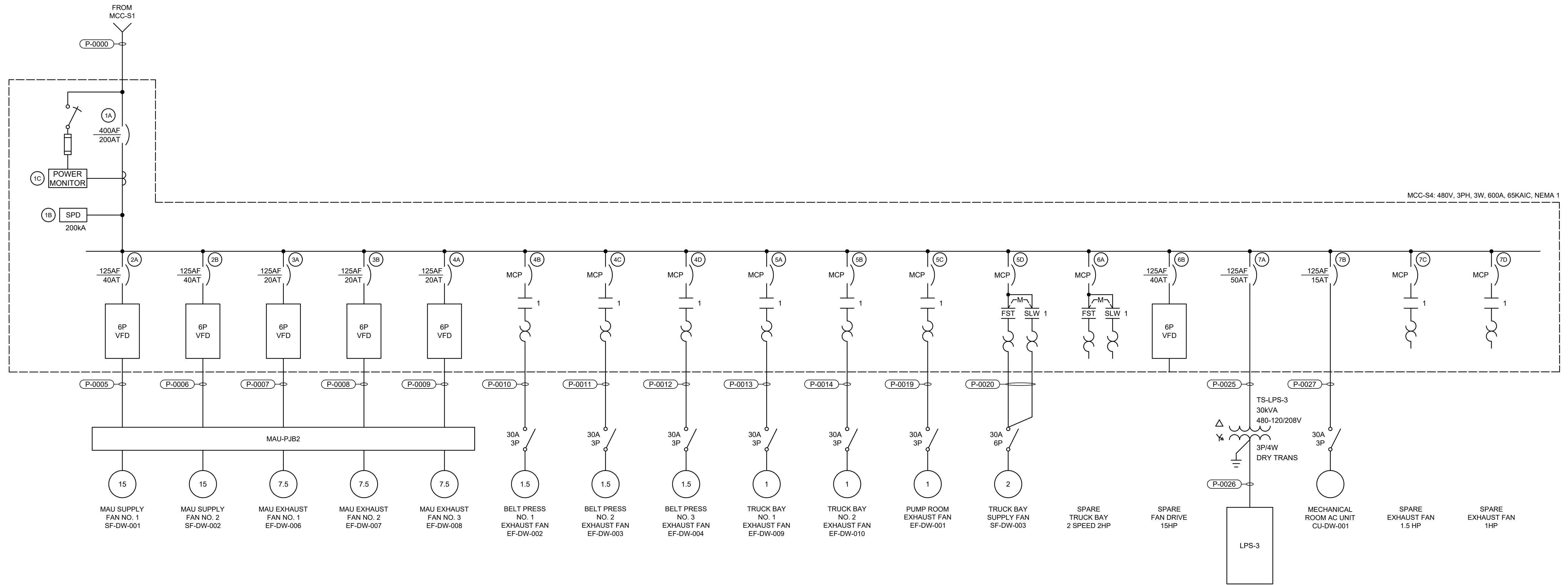
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
MCC-S1 ELEVATIONS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E012





MCC-S4  
SINGLE LINE DIAGRAM

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REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
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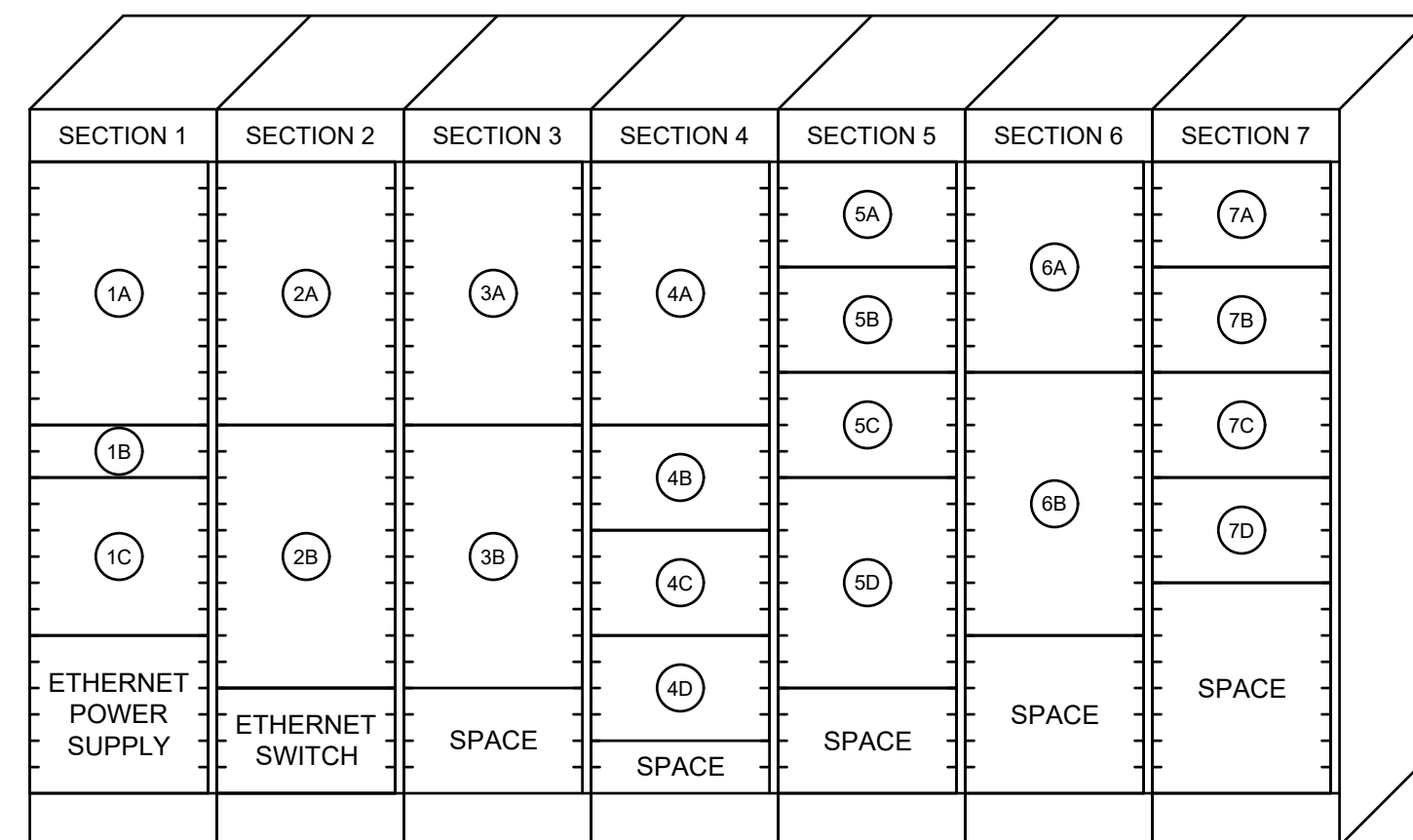
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OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
MCC-S4 SINGLE LINE DIAGRAM

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E013

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 PLOT DATE: 10/21/2024, 9:53 AM BY: ETOLEDO



**MCC-S4**  
ELEVATION

REV	ISSUED FOR	DATE	CNT	BY
1	BID SET	10/2024	CNT	

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET

**Hazen**

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DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
MCC-S4 ELEVATION

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E014

208/120 VOLTS 3-PHASE, 4-WIRE 22kAIC (MINIMUM)		LPS-3 100 MAIN BREAKER 150A 3P			TYPE: NEMA 1 MOUNT: SURFACE										
MODS	DESCRIPTION	CONDUIT/ WIRE	TRIP	POLE	CKT No.	VOLT-AMPERES			VOLT-AMPERES	CKT No.	POLE	TRIP	CONDUIT/ WIRE	DESCRIPTION	MODS
						A	B	C							
-	CU-DW-002	NOTE 2	25	2	1	1,976			100	2	1	20	NOTE 1	AIT-H0623	-
-	AC-DW-001	NOTE 1	15	1	5		1,976		100	4	1	20	NOTE 1	AIT-H0624	-
-	RIQ-DW-002	NOTE 1	20	1	7	1,000			100	6	1	20	NOTE 1	AIT-H0625	-
-	FACP	NOTE 1	20	1	9		500		100	8	1	20	NOTE 1	AIT-H0672	-
-	UH-DW-001	NOTE 1	20	1	11			550	100	10	1	20	NOTE 1	AIT-H0673	-
-	UH-DW-002	NOTE 1	20	1	13	550			-	12	1	20	NOTE 1	MAU LIGHTING	-
-	GF-DW-001	NOTE 1	20	1	15		500		-	14	1	20		SPARE	-
-	EC-DW-001	NOTE 1	20	1	17			1,000	-	16	1	20		SPARE	-
-	SPARE		20	1	19	-			-	18	1	20		SPARE	-
-	RECEPTACLE ROOF NORTH	NOTE 1	20	1	21		180		-	20	1	20		SPARE	-
-	RECEPTACLE ROOF SOUTH	NOTE 1	20	1	23			180	-	22	1	20		SPARE	-
-	RECEPTACLE ROOF WEST	NOTE 1	20	1	25	180			200	24	1	20	NOTE 1	FSL-H0631	-
-	MD-DW-001	NOTE 1	20	1	27		100		200	26	1	20	NOTE 1	FSL-H0632	-
-	MD-DW-002	NOTE 1	20	1	29			100	200	28	1	20	NOTE 1	FSL-H0633	-
-	MD-DW-003	NOTE 1	20	1	31	100			200	30	1	20	NOTE 1	FSL-H0682	-
-	MD-DW-004	NOTE 1	20	1	33		100		200	32	1	20	NOTE 1	FSL-H0683	-
-	MD-DW-005	NOTE 1	20	1	35			100	-	34	1	20		SPARE	-
-	MD-DW-006	NOTE 1	20	1	37	100			200	36	1	20	NOTE 1	FSL-H0612	-
-	MD-DW-007	NOTE 1	20	1	39		100		200	38	1	20	NOTE 1	FSL-H0681	-
-	MD-DW-010	NOTE 1	20	1	41			100	200	40	1	20	NOTE 1	FSL-H0654	-
									200	42	1	20	NOTE 1	FSL-H0665	-

MODIFICATION (MODS) LEGEND:			
GFCI - GROUND FAULT CIRCUIT INTERRUPTER (5mA)			
EPD - EQUIPMENT PROTECTION DEVICE (30mA GFCI)			
LOD - LOCK-ON DEVICE / LFD - LOCK-OFF DEVICE			
ETU - ELECTRONIC TRIP UNIT			

TOTAL	3,906	3,456	3,722
PHASE TOTAL (VA)			
	4,706	4,056	4,922
PHASE TOTAL (A)			
	39	34	41

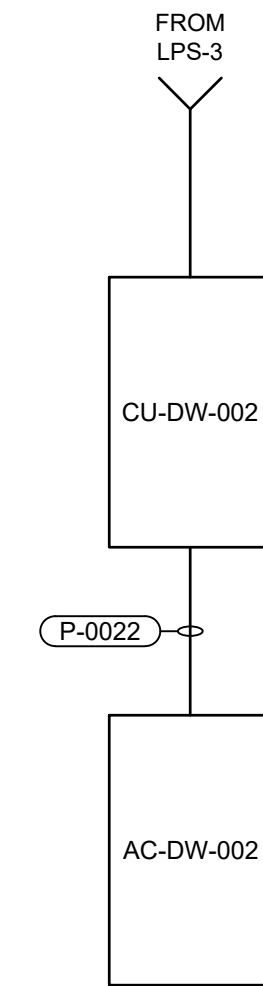
  

800	600	1,200	TOTAL
TOTAL LOAD (VA)			
13,684			
TOTAL LOAD (A)			
38			

NOTES/ACCESSORIES:  
100KA SPD

CKT WIRE/CONDUIT NOTES (WHERE NOTED IN SCHEDULE):  
1. FURNISH AND INSTALL (2#12, #12 GND) IN 3/4".  
2. FURNISH AND INSTALL (2#10, #10 GND) IN 3/4".



File: C:\USERS\ETOLED\DRAWING\HAZEN AND SAWYER\70123-000\_CWSID DEWATERING BUILDING HVAC IMPROV\PROJECT FILES\01\_DESIGN\ELECTRICAL\15 Saved by ETOLEDO Save date: 10/21/2024 9:23 AM  
PLOT DATE: 10/21/2024 9:53 AM BY: ETOLEDO

PROJECT ENGINEER:	C. THUNHORST
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BID SET

# Hazen

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CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

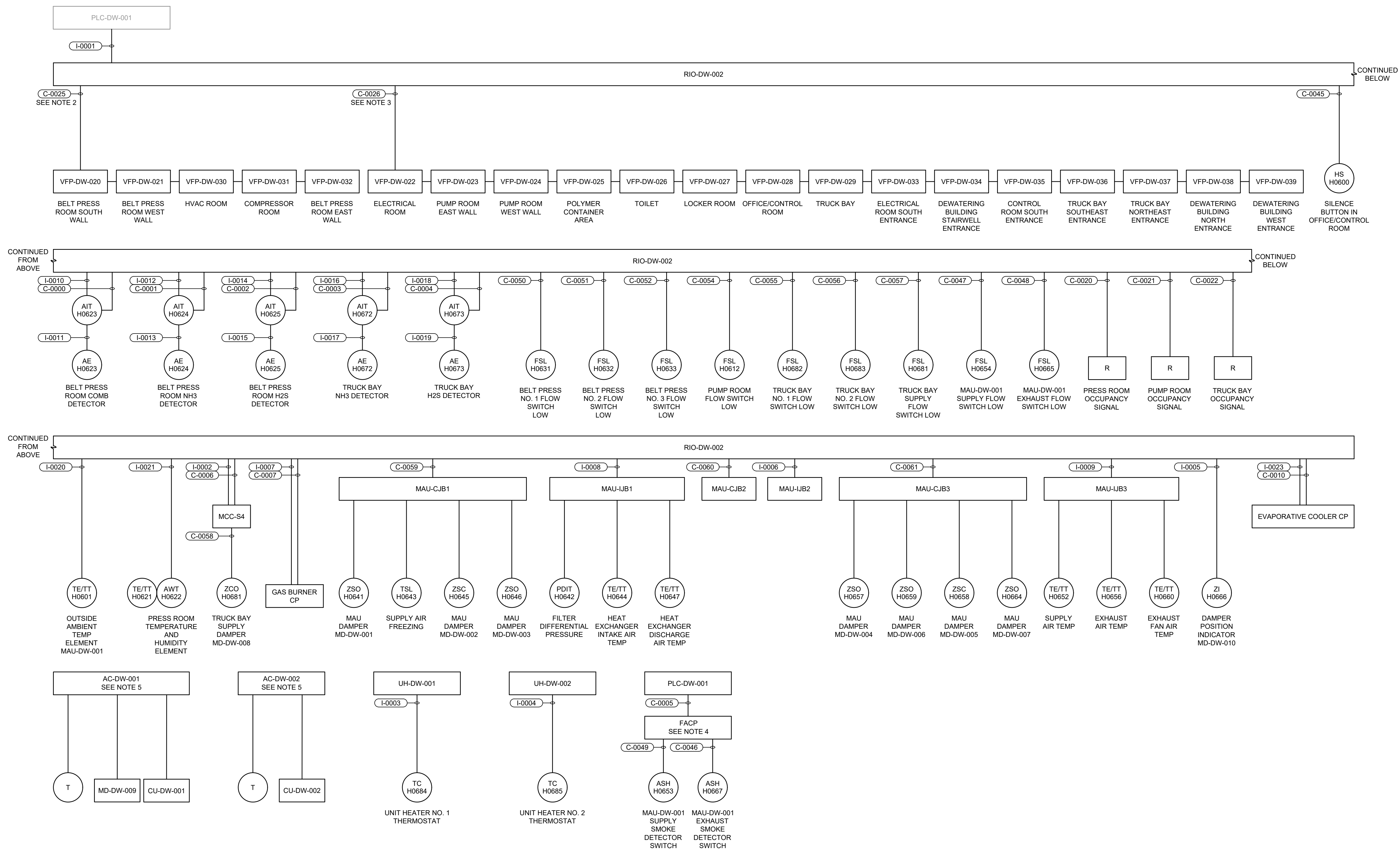
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
PANEL SCHEDULE

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E015

NOTES:

1. MAU EQUIPMENT AND DEVICES WILL BE PRE-WIRED TO JUNCTION BOXES ON UNIT. CONFIGURATION AND WIRING SHOWN ARE PRELIMINARY ASSUMPTIONS. EXACT CONFIGURATION AND WIRING TO MATCH MAU AS-BUILD REQUIREMENTS.
2. CONNECT ALL VENTILATION FAILURE PANELS (VFP) ON SECOND FLOOR TO THESE CIRCUITS. EXACT ORDER/CONFIGURATION OF DEVICES TO BE DETERMINED IN THE FIELD.
3. CONNECT ALL VENTILATION FAILURE PANELS (VFP) ON FIRST FLOOR TO THESE CIRCUITS. EXACT ORDER/CONFIGURATION OF DEVICES TO BE DETERMINED IN THE FIELD.
4. FIRE ALARM SYSTEM SHALL BE PROVIDED AS SPECIFIED IN SPECIFICATION SECTION 28 46 20. INSTALL SMOKE DETECTORS AS REQUIRED. ONLY HVAC DUCT MOUNTED DETECTORS ARE SHOWN ON THIS PLAN.
5. ELECTRICAL CONTRACTOR TO INSTALL CONTROL CONDUITS FOR AC-DW-001 AND AC-DW-002. HVAC CONTRACTOR TO INSTALL CONTROL WIRING. COORDINATE EXACT REQUIREMENTS WITH HVAC CONTRACTOR.



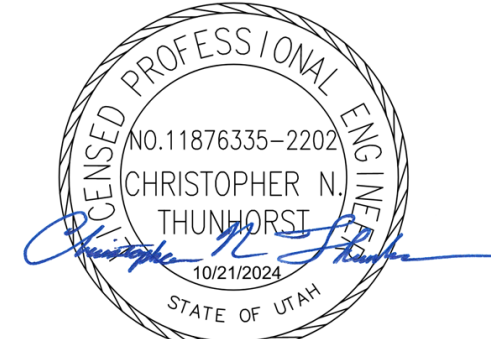
CONTROLS ONE LINE DIAGRAM

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 PLOT DATE: 10/21/2024 9:53 AM BY: ETOLED0

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REV	ISSUED FOR	DATE	BY

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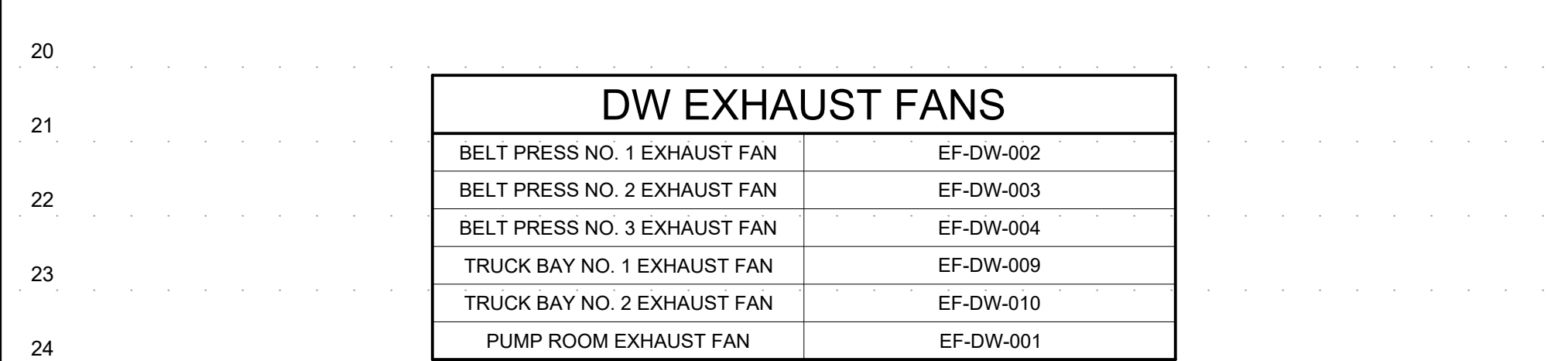
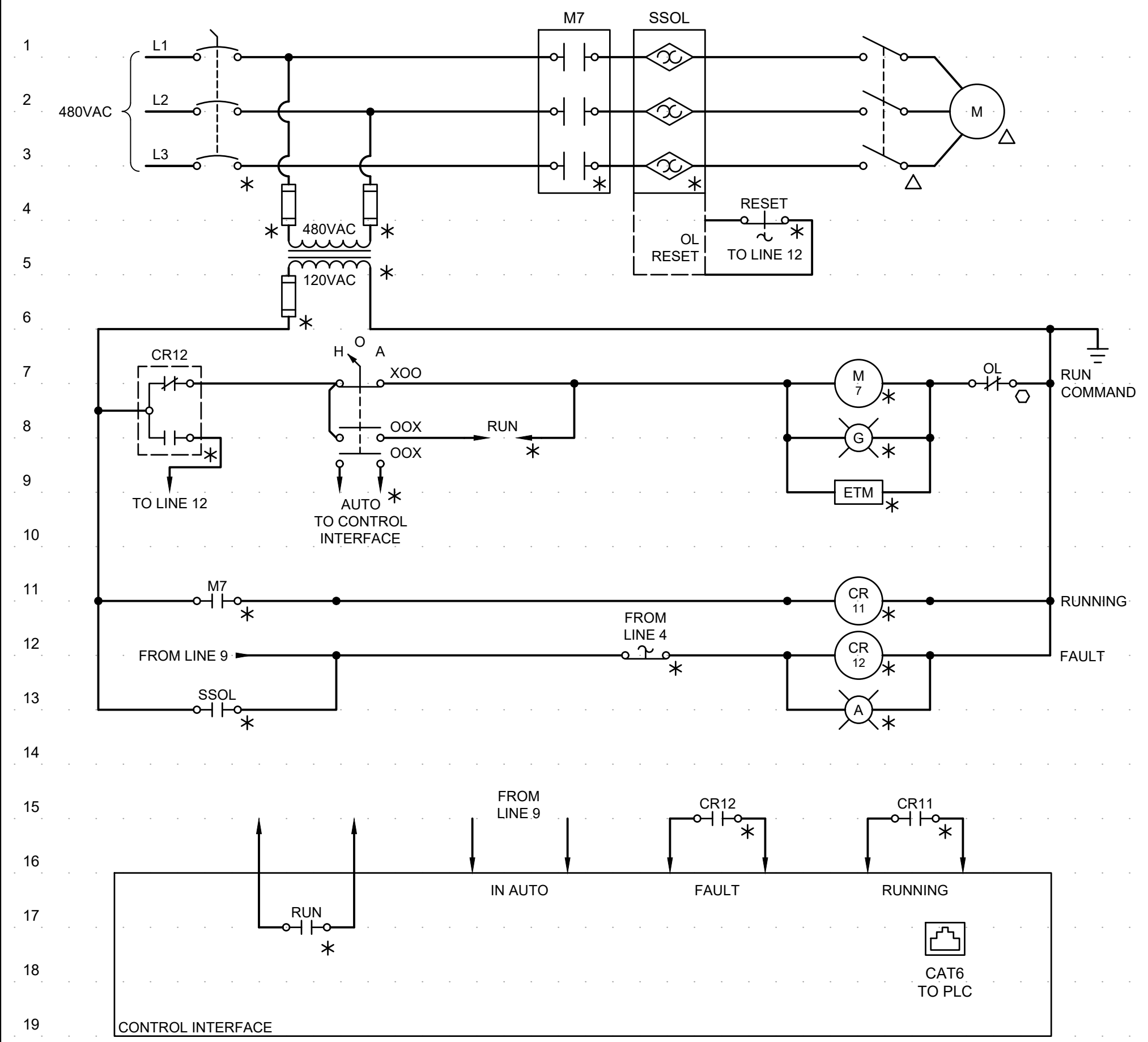
**Hazen**  
 HAZEN AND SAWYER  
 10619 SOUTH JORDAN GATEWAY,  
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CENTRAL WEBER  
 SEWER IMPROVEMENT DISTRICT  
 OGDEN, UT  
 DEWATERING BUILDING HVAC  
 IMPROVEMENTS

ELECTRICAL  
 CONTROLS ONE LINE DIAGRAM

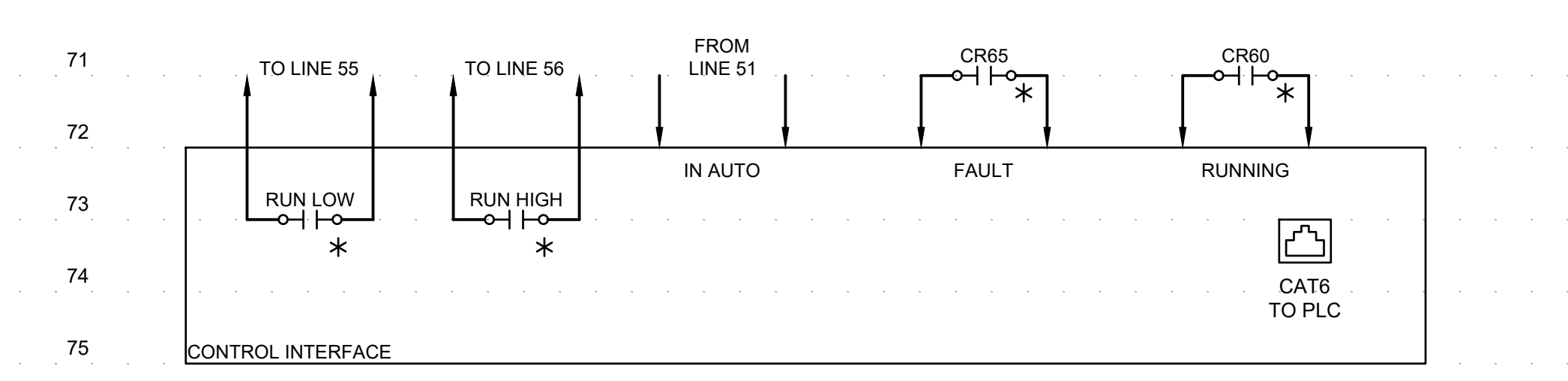
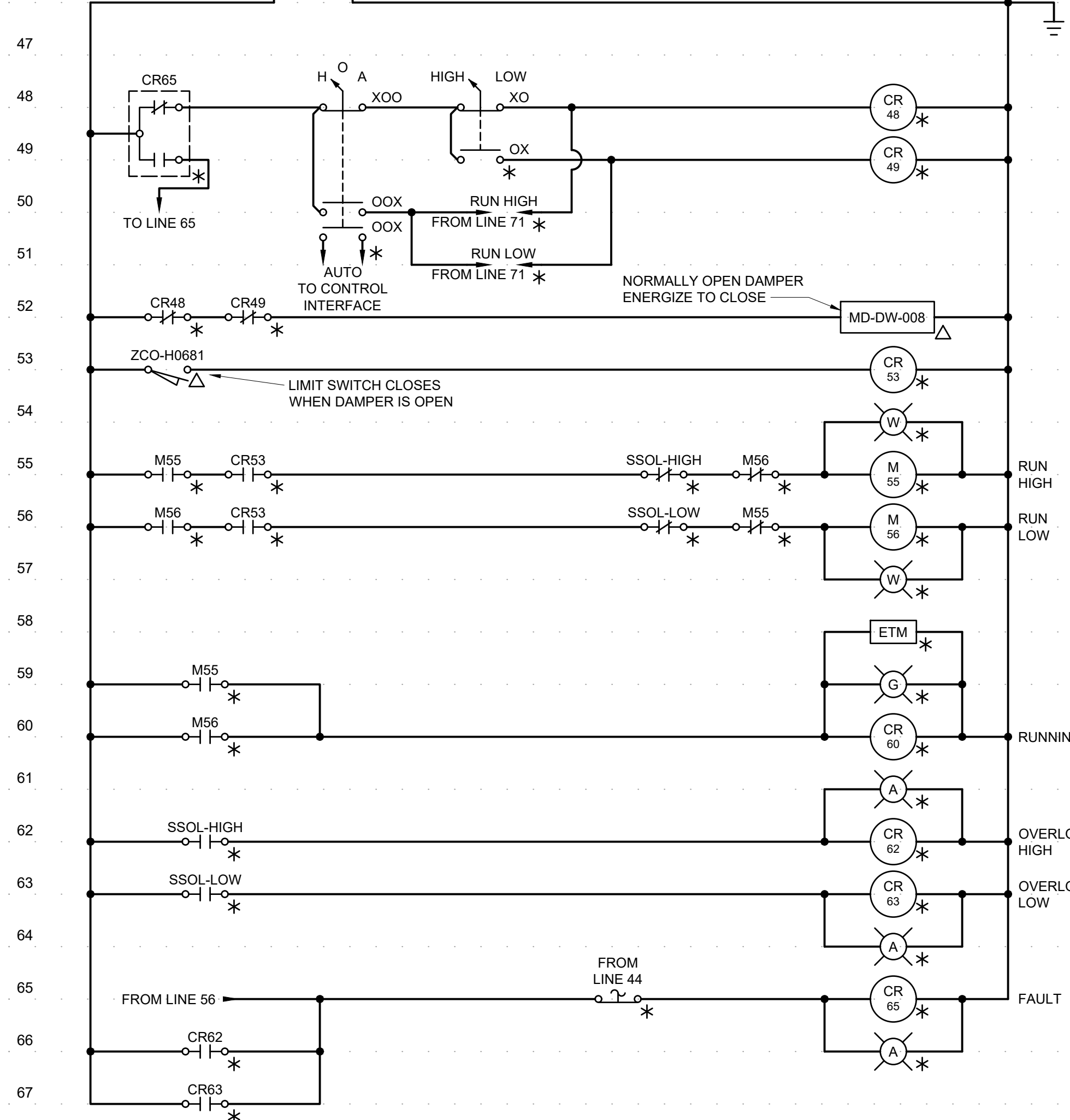
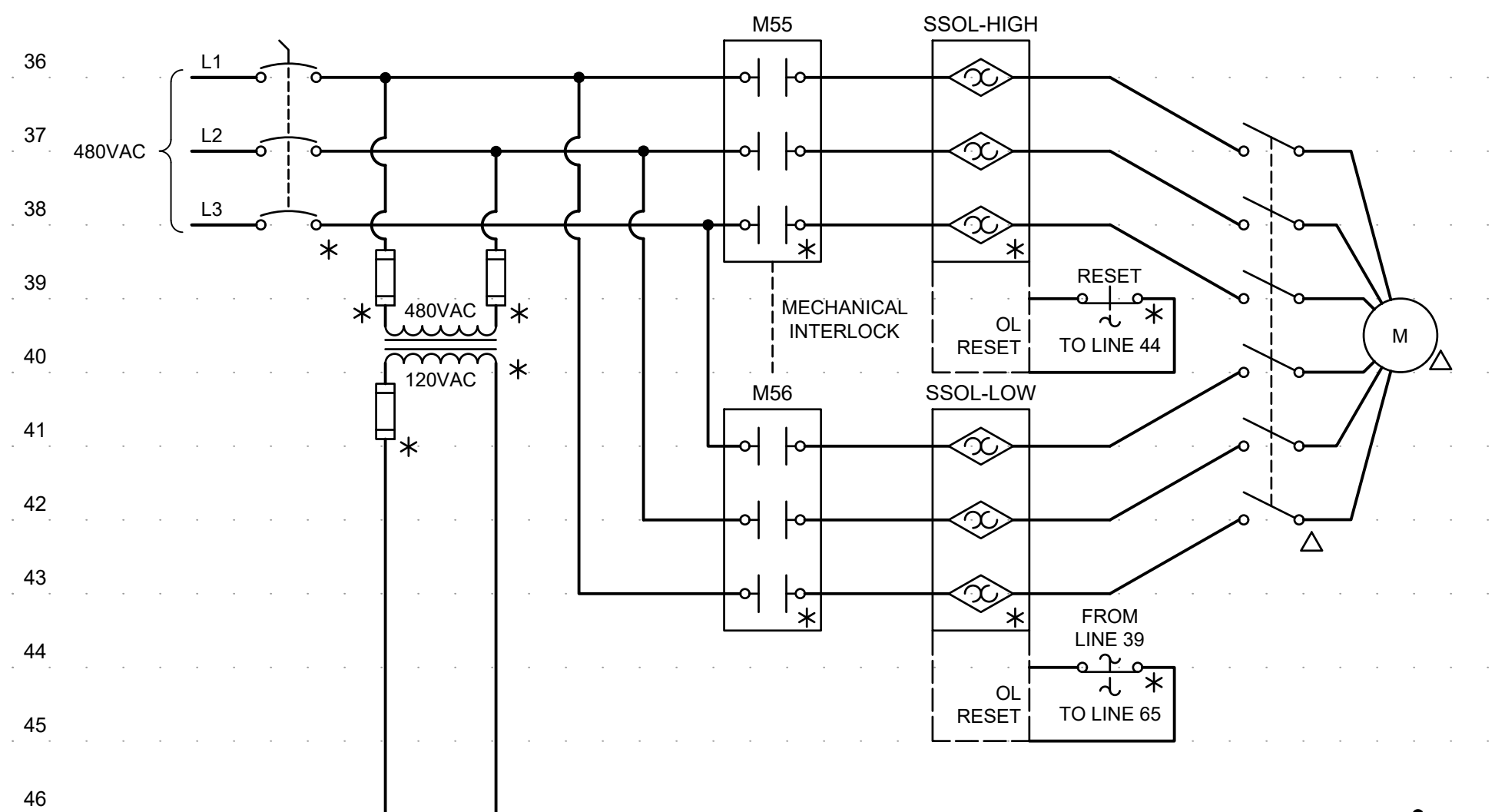
DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E016





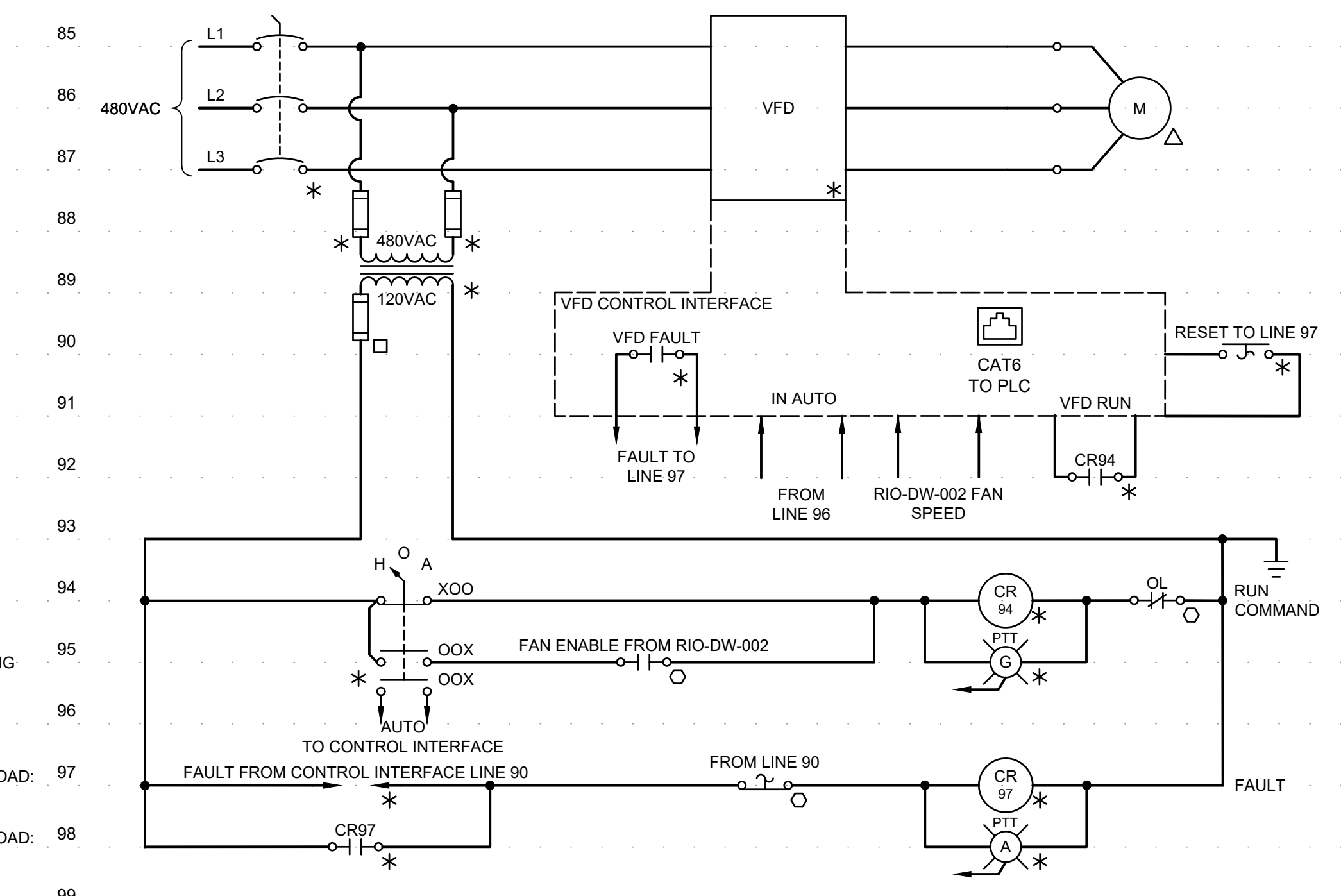
DW EXHAUST FANS	
BELT PRESS NO. 1 EXHAUST FAN	EF-DW-002
BELT PRESS NO. 2 EXHAUST FAN	EF-DW-003
BELT PRESS NO. 3 EXHAUST FAN	EF-DW-004
TRUCK BAY NO. 1 EXHAUST FAN	EF-DW-009
TRUCK BAY NO. 2 EXHAUST FAN	EF-DW-010
PUMP ROOM EXHAUST FAN	EF-DW-001

**DW EXHAUST FANS**  
ELEMENTARY SCHEMATIC



**TRUCK BAY FAN**  
TRUCK BAY SUPPLY FAN SF-DW-003

**TRUCK BAY FAN**  
ELEMENTARY SCHEMATIC



MAU FANS	
SUPPLY FAN NO. 1	SF-DW-001
SUPPLY FAN NO. 2	SF-DW-002
EXHAUST FAN NO. 1	EF-DW-006
EXHAUST FAN NO. 2	EF-DW-007
EXHAUST FAN NO. 3	EF-DW-008

**MAU FANS**  
ELEMENTARY SCHEMATIC

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 PLOT DATE: 10/21/2024 9:53 AM BY: ETOLED0

REV	ISSUED FOR	DATE	BY

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CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
ELEMENTARY CONTROL SCHEMATICS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E017

NOTES:

- VFD CABLE SHALL BE PROVIDED WITH SEGMENTED GROUND CONFIGURATION, GROUND CONDUCTOR SIZING BY VFD MANUFACTURER.

CONDUIT NO.	SIZE	FROM	TO	CONDUCTORS	REMARKS
P-0000	3"	MCC-S1	MCC-S4	3#3/0, 1#3 GND	
P-0001				THIS CONDUIT IS NOT USED	
P-0002				THIS CONDUIT IS NOT USED	
P-0003				THIS CONDUIT IS NOT USED	
P-0004				THIS CONDUIT IS NOT USED	
P-0005	2"	MCC-S4	SF-DW-001	1-#8 VFD CABLE, 1#8 GND	
P-0006	2"	MCC-S4	SF-DW-002	1-#8 VFD CABLE, 1#8 GND	
P-0007	2"	MCC-S4	EF-DW-006	1-#12 VFD CABLE, 1#10 GND	
P-0008	2"	MCC-S4	EF-DW-007	1-#12 VFD CABLE, 1#10 GND	
P-0009	2"	MCC-S4	EF-DW-008	1-#12 VFD CABLE, 1#10 GND	
P-0010	3/4"	MCC-S4	EF-DW-002	3#12, 1#12 GND	THROUGH DSW
P-0011	3/4"	MCC-S4	EF-DW-003	3#12, 1#12 GND	THROUGH DSW
P-0012	3/4"	MCC-S4	EF-DW-004	3#12, 1#12 GND	THROUGH DSW
P-0013	3/4"	MCC-S4	EF-DW-009	3#12, 1#12 GND	THROUGH DSW
P-0014	3/4"	MCC-S4	EF-DW-010	3#12, 1#12 GND	THROUGH DSW
P-0015				THIS CONDUIT IS NOT USED	
P-0016				THIS CONDUIT IS NOT USED	
P-0017				THIS CONDUIT IS NOT USED	
P-0018				THIS CONDUIT IS NOT USED	
P-0019	3/4"	MCC-S4	EF-DW-001	3#12, 1#12 GND	THROUGH DSW
P-0020	1"	MCC-S4	SF-DW-003	6#12, 1#12 GND	THROUGH DSW
P-0021				THIS CONDUIT IS NOT USED	
P-0022	3/4"	CU-DW-002	AC-DW-002	2#12, 1#12 GND	
P-0023				THIS CONDUIT IS NOT USED	
P-0024				THIS CONDUIT IS NOT USED	
P-0025	1"	MCC-S4	TS-LPS-3	3#8, 1#8 GND	
P-0026	1 1/2"	TS-LPS-3	LPS-3	4#1, 1#6 GND	
P-0027	3/4"	MCC-S4	CU-DW-001	3#10, 1#10 GND	THROUGH DSW

CONDUIT NO.	SIZE	FROM	TO	CONDUCTORS	REMARKS
I-0000				THIS CONDUIT IS NOT USED	
I-0001	3/4"	PLC-DW-001	RIO-DW-002	1-CAT6	
I-0002	3/4"	RIO-DW-002	MCC-S4	1-CAT6	
I-0003	3/4"	UH-DW-001	TC-H0684	PER MFR.	
I-0004	3/4"	UH-DW-002	TC-H0685	PER MFR.	
I-0005	3/4"	RIO-DW-002	MD-DW-010	2(2/C#16TSH, #14 GND)	
I-0006	1"	RIO-DW-002	MAU-IJB2	EMPTY W/PULLSTRING	SPARE
I-0007	1"	RIO-DW-002	GAS BURNER CP	3(2/C#16TSH, #14 GND)	
I-0008	1"	RIO-DW-002	MAU-IJB1	3(2/C#16TSH, #14 GND)	
I-0009	1"	RIO-DW-002	MAU-IJB3	3(2/C#16TSH, #14 GND)	
I-0010	3/4"	RIO-DW-002	AIT-H0623	2/C#16TSH, #14 GND	
I-0011	3/4"	AIT-H0623	AE-H0623	VENDOR CABLE	
I-0012	3/4"	RIO-DW-002	AIT-H0624	2/C#16TSH, #14 GND	
I-0013	3/4"	AIT-H0624	AE-H0624	VENDOR CABLE	
I-0014	3/4"	RIO-DW-002	AIT-H0625	2/C#16TSH, #14 GND	
I-0015	3/4"	AIT-H0625	AE-H0625	VENDOR CABLE	
I-0016	3/4"	RIO-DW-002	AIT-H0672	2/C#16TSH, #14 GND	
I-0017	3/4"	AIT-H0672	AE-H0672	VENDOR CABLE	
I-0018	3/4"	RIO-DW-002	AIT-H0673	2/C#16TSH, #14 GND	
I-0019	3/4"	AIT-H0673	AE-H0673	VENDOR CABLE	
I-0020	3/4"	RIO-DW-002	TE/TT-H0601	2/C#16TSH, #14 GND	
I-0021	3/4"	RIO-DW-002	TE/TT-H0621 & AWT-H0622	2(2/C#16TSH, #14 GND)	
I-0022				THIS CONDUIT IS NOT USED	
I-0023	1"	RIO-DW-002	EVAPORATIVE COOLER CONTROL PANEL	4(2/C#16TSH, #14 GND)	

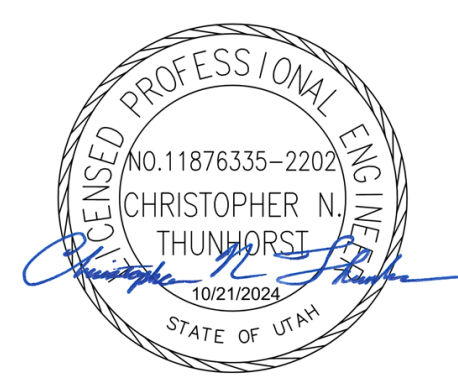
CONDUIT NO.	SIZE	FROM	TO	CONDUCTORS	REMARKS
C-0000	3/4"	RIO-DW-002	AIT-H0623	2#14 AWG, #14 GND	
C-0001	3/4"	RIO-DW-002	AIT-H0624	2#14 AWG, #14 GND	
C-0002	3/4"	RIO-DW-002	AIT-H0625	2#14 AWG, #14 GND	
C-0003	3/4"	RIO-DW-002	AIT-H0672	2#14 AWG, #14 GND	
C-0004	3/4"	RIO-DW-002	AIT-H0673	2#14 AWG, #14 GND	
C-0005	3/4"	PLC-DW-001	FACP	6#14 AWG, #14 GND)	
C-0006	3/4"	RIO-DW-002	MCC-S4	2#14 AWG, #14 GND	
C-0007	1"	RIO-DW-002	GAS BURNER CONTROL PANEL	6#14 AWG, #14 GND)	
C-0008				THIS CONDUIT IS NOT USED	
C-0009				THIS CONDUIT IS NOT USED	
C-0010	3/4"	RIO-DW-002	EVAPORATIVE COOLER CONTROL PANEL	6#14 AWG, #14 GND	
C-0011				THIS CONDUIT IS NOT USED	
C-0012				THIS CONDUIT IS NOT USED	
C-0013				THIS CONDUIT IS NOT USED	
C-0014				THIS CONDUIT IS NOT USED	
C-0015				THIS CONDUIT IS NOT USED	
C-0016				THIS CONDUIT IS NOT USED	
C-0017				THIS CONDUIT IS NOT USED	
C-0018				THIS CONDUIT IS NOT USED	
C-0019				THIS CONDUIT IS NOT USED	
C-0020	3/4"	RIO-DW-002	PRESS ROOM OCCUPANCY RELAY	2#14 AWG, #14 GND	
C-0021	3/4"	RIO-DW-002	PUMP ROOM OCCUPANCY RELAY	2#14 AWG, #14 GND	
C-0022	3/4"	RIO-DW-002	TRUCK BAY OCCUPANCY RELAY	2#14 AWG, #14 GND	
C-0023				THIS CONDUIT IS NOT USED	
C-0024				THIS CONDUIT IS NOT USED	
C-0025	3/4"	RIO-DW-002	SECOND FLOOR VFPS	6#14 AWG, #14 GND	
C-0026	3/4"	RIO-DW-002	FIRST FLOOR VFPS	6#14 AWG, #14 GND	
C-0027				THIS CONDUIT IS NOT USED	
C-0028				THIS CONDUIT IS NOT USED	
C-0029				THIS CONDUIT IS NOT USED	
C-0030				THIS CONDUIT IS NOT USED	
C-0031				THIS CONDUIT IS NOT USED	
C-0032				THIS CONDUIT IS NOT USED	
C-0033				THIS CONDUIT IS NOT USED	
C-0034				THIS CONDUIT IS NOT USED	
C-0035				THIS CONDUIT IS NOT USED	
C-0036				THIS CONDUIT IS NOT USED	
C-0037				THIS CONDUIT IS NOT USED	
C-0038				THIS CONDUIT IS NOT USED	
C-0039				THIS CONDUIT IS NOT USED	
C-0040				THIS CONDUIT IS NOT USED	
C-0041				THIS CONDUIT IS NOT USED	
C-0042				THIS CONDUIT IS NOT USED	
C-0043				THIS CONDUIT IS NOT USED	
C-0044				THIS CONDUIT IS NOT USED	
C-0045	3/4"	RIO-DW-002	HS-H0600	2#14 AWG, #14 GND	
C-0046	3/4"	FACP	ASH-H0667	PER MFR.	
C-0047	3/4"	RIO-DW-002	FSL-H0654	2#14 AWG, #14 GND	
C-0048	3/4"	RIO-DW-002	FSL-H0665	2#14 AWG, #14 GND	
C-0049	3/4"	FACP	ASH-H0653	PER MFR.	
C-0050	3/4"	RIO-DW-002	FSL-H0631	2#14 AWG, #14 GND	
C-0051	3/4"	RIO-DW-002	FSL-H0632	2#14 AWG, #14 GND	
C-0052	3/4"	RIO-DW-002	FSL-H0633	2#14 AWG, #14 GND	
C-0053				THIS CONDUIT IS NOT USED	
C-0054	3/4"	RIO-DW-002	FSL-H0612	2#14 AWG, #14 GND	
C-0055	3/4"	RIO-DW-002	FSL-H0682	2#14 AWG, #14 GND	
C-0056	3/4"	RIO-DW-002	FSL-H0683	2#14 AWG, #14 GND	
C-0057	3/4"	RIO-DW-002	FSL-H0681	2#14 AWG, #14 GND	
C-0058	3/4"	MCC-S4	ZCO-H0681	2#14 AWG, #14 GND	
C-0059	3/4"	RIO-DW-002	MAU-CJB1	14#14 AWG, #14 GND	
C-0060	3/4"	RIO-DW-002	MAU-CJB2	EMPTY W/PULLSTRING	SPARE
C-0061	1"	RIO-DW-002	MAU-CJB3	16#14 AWG, #14 GND	

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REV	ISSUED FOR	DATE	CNT	BY
1	BID SET	10/2024	CNT	

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET



# Hazen

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

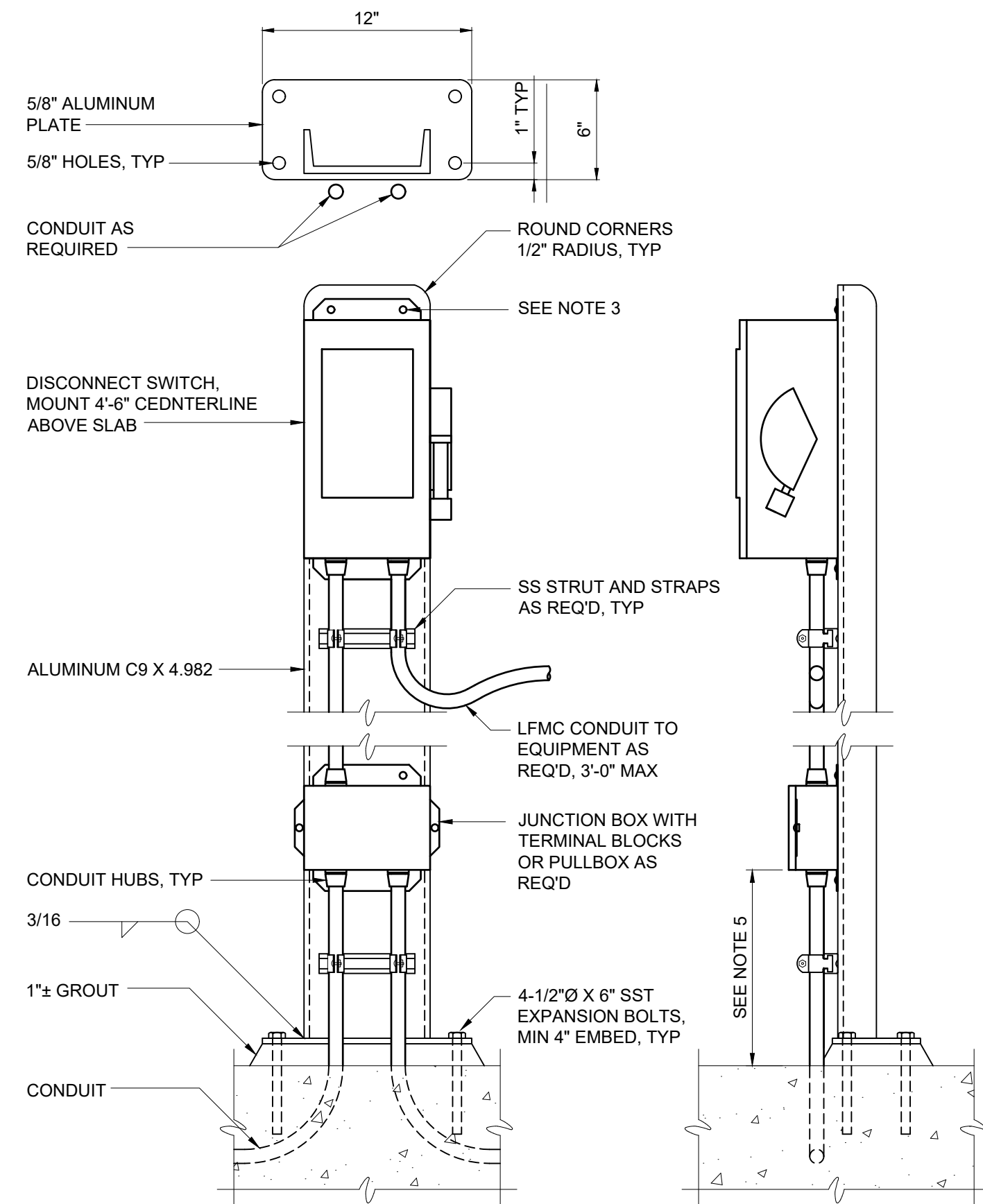
CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
CONDUIT SCHEDULES

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E018

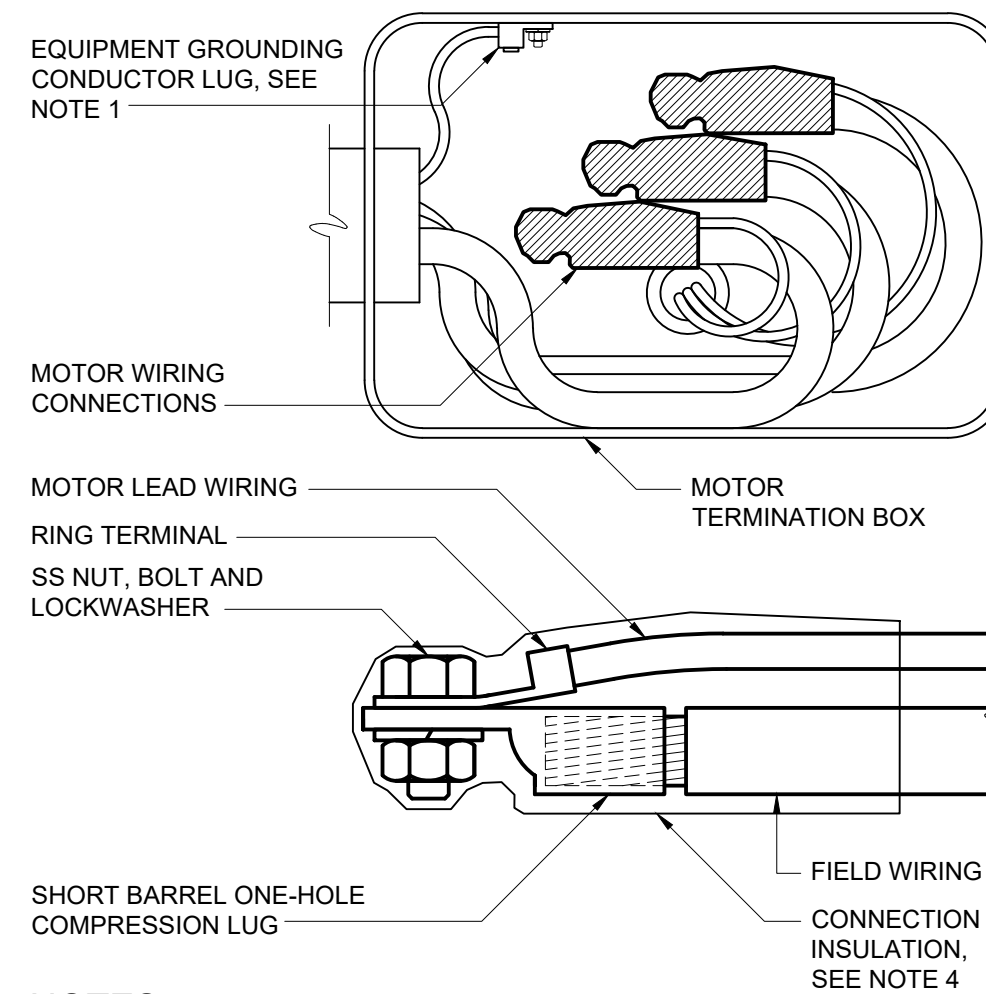




**NOTES:**

1. COAT ALUMINUM SURFACES IN CONTACT WITH CONCRETE PER SPECIFICATIONS.
2. CONSTRUCT 1'-2" DIAMETER X 2'-6" DEEP FOUNDATION WHERE MOUNTING SURFACE IS NOT AVAILABLE.
3. USE SST WASHERS, LOCKWASHERS, NUTS AND BOLTS FOR MOUNTING EQUIPMENT AND STRUT SUPPORTS TO CHANNEL. DRILL EQUIPMENT MOUNTING TABS AS NECESSARY TO COORDINATE WITH CHANNEL WIDTH.
4. REFERENCE STANDARD DETAIL E-26-0102 WHERE CONDUIT EMERGES FROM CONCRETE.
5. COORDINATE MOUNTING HEIGHT ABOVE CONCRETE WITH AREA CLASSIFICATION REQUIREMENTS.

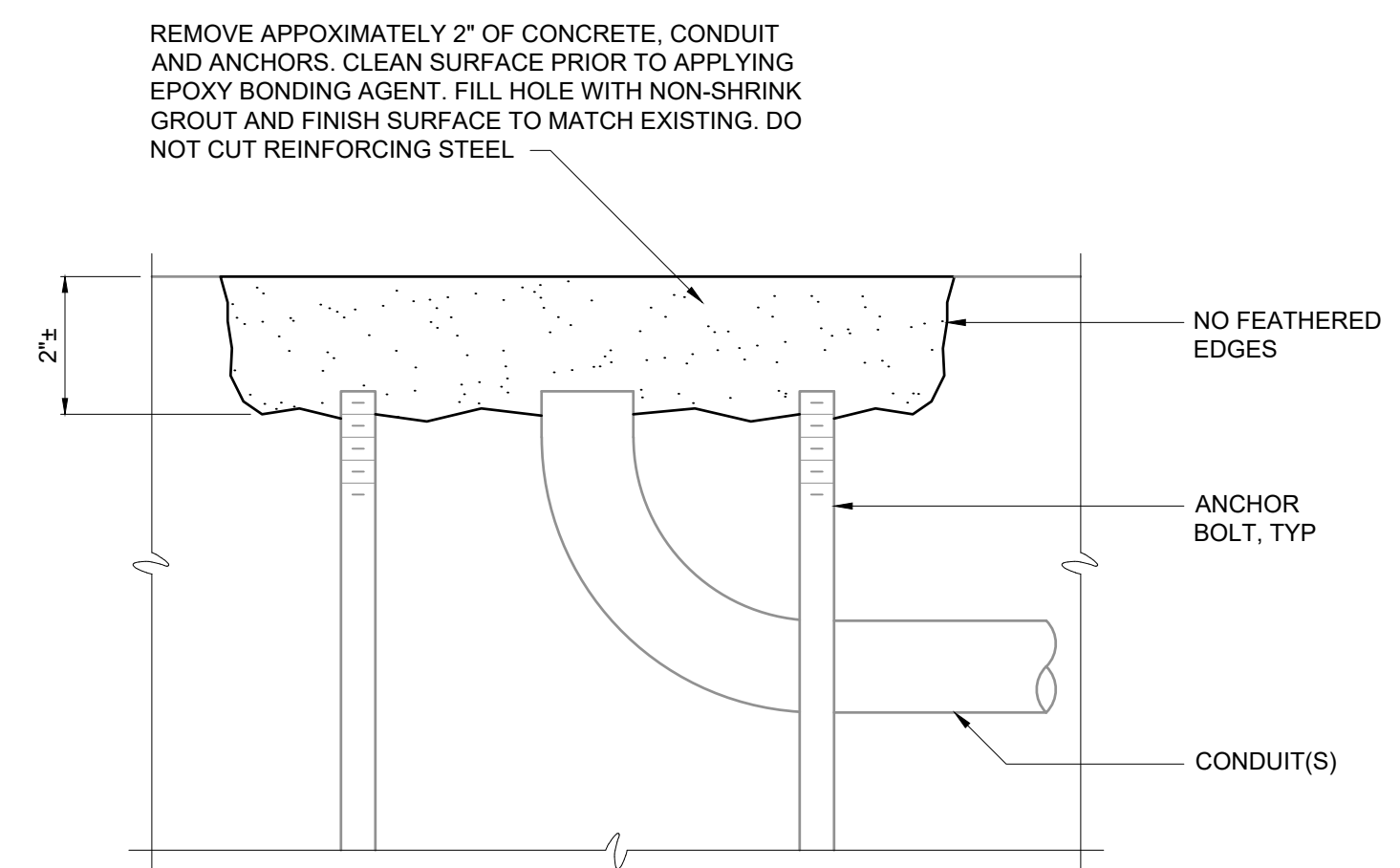
30 AND 60 AMP DISCONNECT SWITCH  
E-26-0403



**NOTES:**

1. EQUIPMENT GROUNDING CONDUCTOR LUG SHALL BE ATTACHED WITH NUT AND LOCKWASHER TO THE MOTOR GROUNDING STUD. WHERE PROVIDED, FACTORY INSTALLED EQUIPMENT GROUNDING CONDUCTOR LUGS ARE ACCEPTABLE IN LIEU OF THE FIELD INSTALLED EQUIPMENT GROUNDING CONDUCTOR LUG.
2. RING TERMINALS ON MOTOR LEADS SHALL BE FACTORY INSTALLED BY THE MOTOR MANUFACTURER.
3. INSTALL SHORT BARREL COMPRESSION CONNECTOR ON FIELD WIRING WITH MANUFACTURER'S RECOMMENDED COMPRESSION TOOL AND CRIMPING DIE. CONNECTORS SHALL HAVE SMOOTHLY ROUNDED EDGES.
4. HEAT SHRINK OR COLD APPLIED CONNECTOR INSULATION LISTED FOR THE PURPOSE AND AS SPECIFIED.

LOW VOLTAGE MOTOR TERMINATION  
E-26-0301



SEALING ABANDONED CONDUIT  
AND ANCHOR BOLTS  
E-26-0103

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	

BID SET

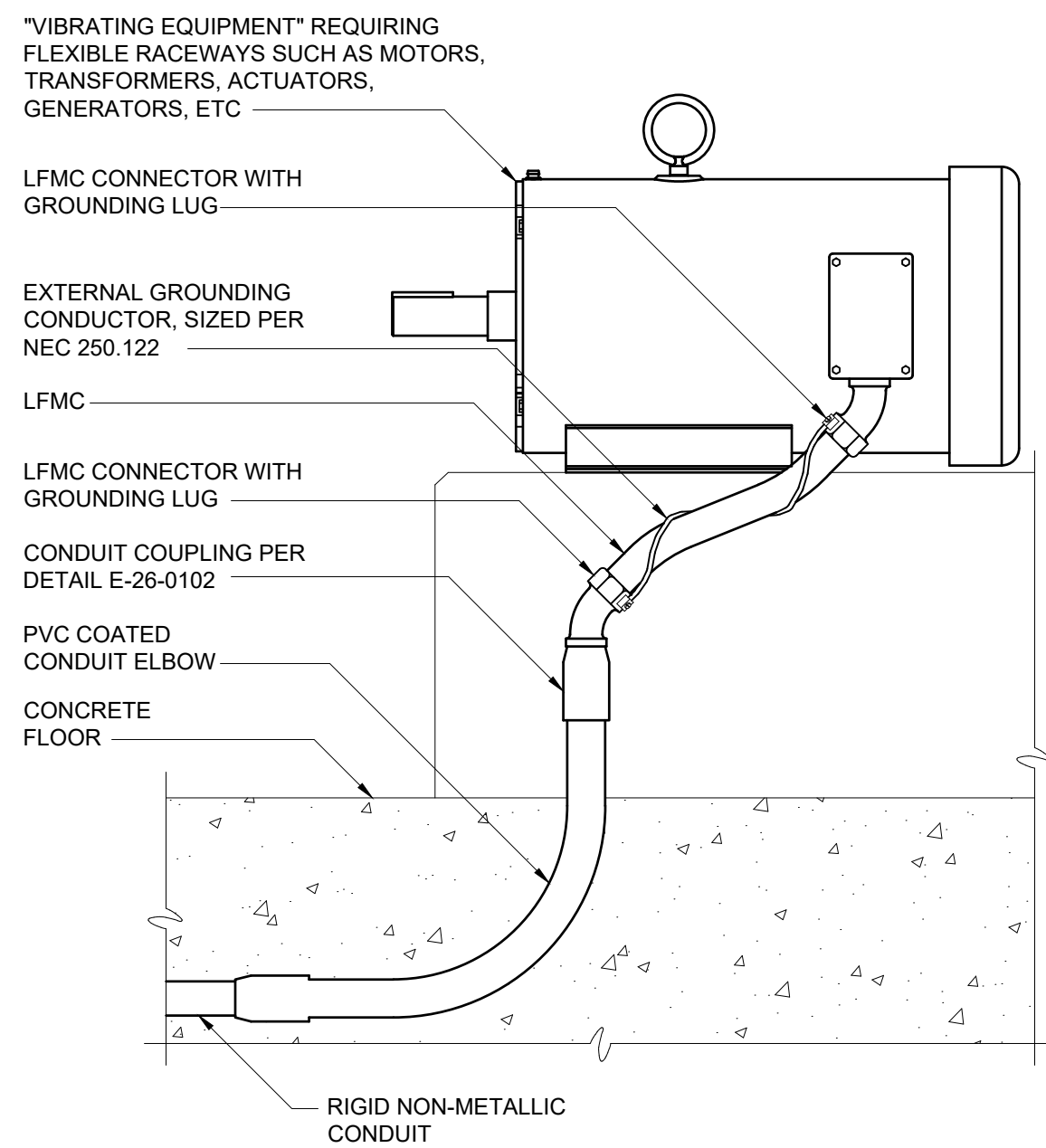


**Hazen**  
HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
STANDARD ELECTRICAL DETAILS - 1

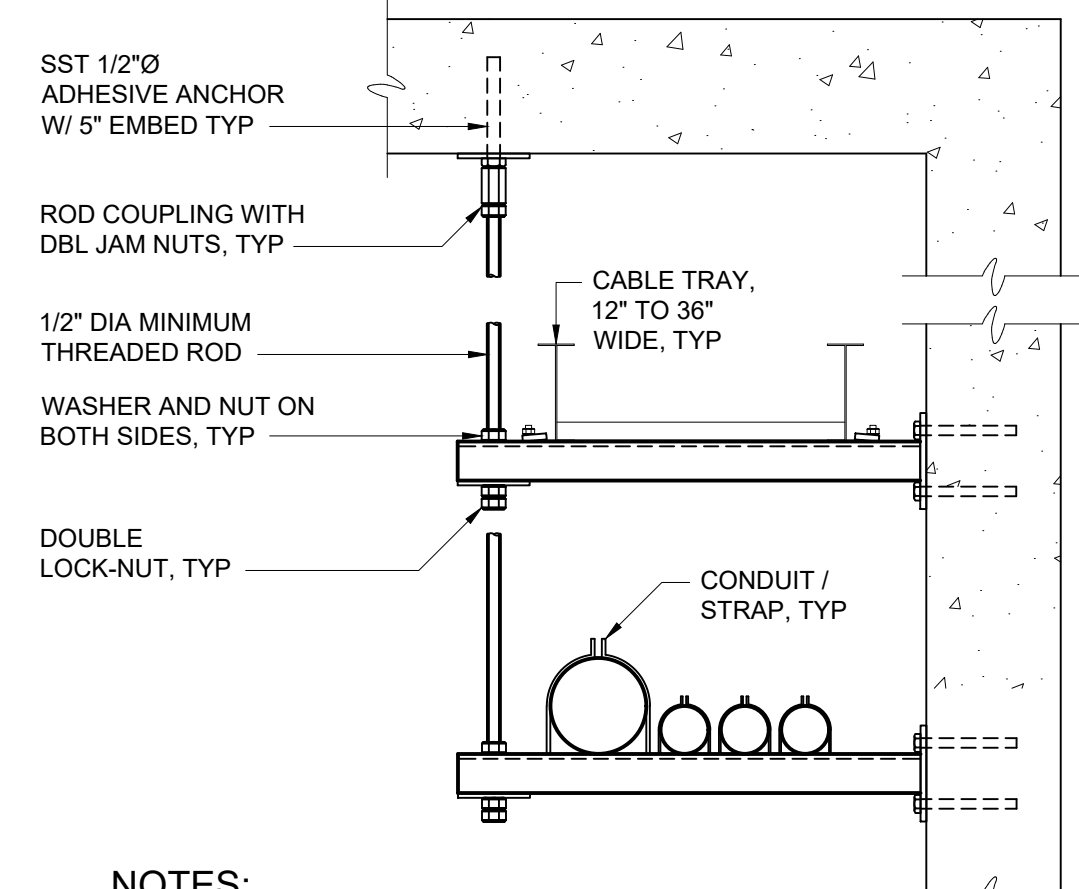
DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E019



**NOTES:**

1. WHERE NON-METALLIC CONDUIT TRANSITIONS TO RIGID METALLIC CONDUIT AND / OR LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT, (LFMC), TO FEED VIBRATING TYPE LOADS, THE CONTRACTOR SHALL FURNISH AND INSTALL AN EXTERNAL BARE COPPER GROUNDING CONDUCTOR AND APPROVED GROUNDING LFMC CONNECTORS TO ENSURE GROUND CONTINUITY TO THE RIGID METALLIC CONDUIT AS SHOWN. THE GROUNDING CONDUCTOR SHALL BE SIZED ACCORDING TO NEC 250.122 AND BE NEATLY WRAPPED AROUND LFMC AS SHOWN. LFMC INSTALLED IN THIS MANNER CANNOT BE USED FOR A CONTINUOUS GROUND PATH PER NEC 350.60.

LFMC CONDUIT GROUND STRAP  
E-26-0104



**NOTES:**

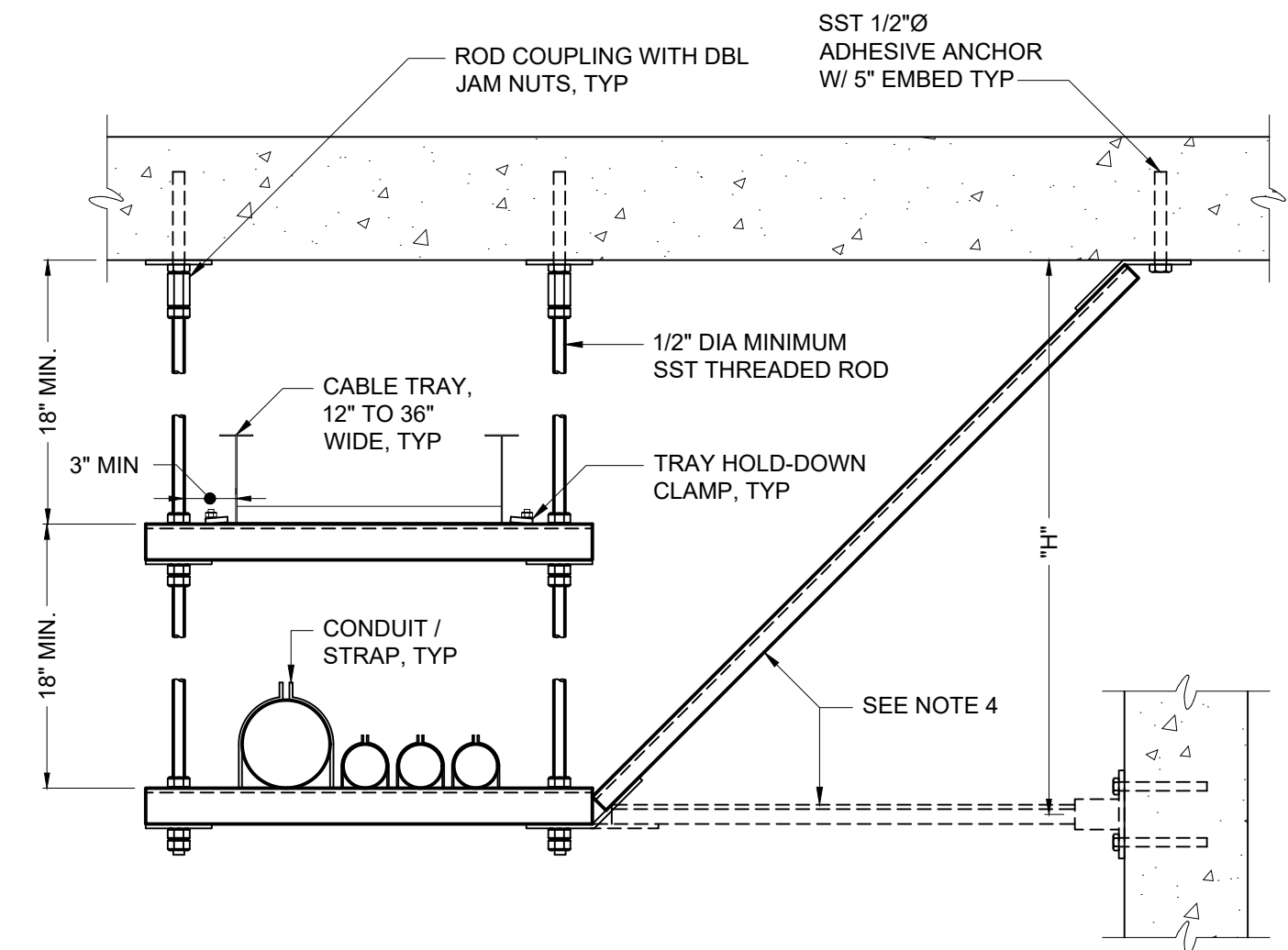
1. SPACE SUPPORTS AT 5'-0" MAXIMUM. HANGER SPACING SHALL BE BASED ON MAXIMUM LOAD.

2. ALL THREAD ROD SHALL BE USED ONLY FOR DUAL TRAY.

3. REFER TO AREA DESIGNATION DRAWINGS AND SPECIFICATIONS FOR REQUIRED MATERIALS OF CONSTRUCTION.

4. STRUT SHALL BE 12 GAUGE MINIMUM.

WALL MOUNTED RACEWAY SUPPORT RACK  
E-26-0202



**NOTES:**

1. SPACE SUPPORTS AT 5'-0" MAXIMUM. HANGER SPACING SHALL BE BASED ON MAXIMUM LOAD.

2. ALL THREAD ROD SHALL BE USED ONLY FOR DUAL TRAYS / RACKS.

3. REFER TO AREA DESIGNATION DRAWINGS AND SPECIFICATIONS FOR REQUIRED MATERIALS OF CONSTRUCTION.

4. PREFORMED BRACING CHANNEL AT 30'-0" SPACING MAX. BRACE AT INTERMEDIATE LEVEL WHEN "H" DIMENSION EXCEEDS 6'-0".

5. STRUT SHALL BE 12 GAUGE MINIMUM.

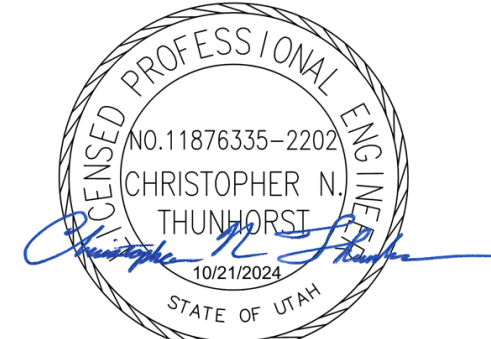
SUSPENDED RACEWAY SUPPORT RACK  
E-26-0201

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1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	C. THUNHORST
DESIGNED BY:	E. TOLEDO
DRAWN BY:	E. TOLEDO
CHECKED BY:	C. THUNHORST

BID SET



**Hazen**

HAZEN AND SAWYER  
10619 SOUTH JORDAN GATEWAY,  
SUITE 130, SOUTH JORDAN, UT 84095

CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

DEWATERING BUILDING HVAC  
IMPROVEMENTS

ELECTRICAL  
STANDARD ELECTRICAL DETAILS - 2

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	E020



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 PLOT DATE: 10/21/2024 9:00 AM BY: TROSE

INSTRUMENT AND FUNCTION SYMBOLS					VALVE, GATE, AND ACTUATOR SYMBOLS					PUMP AND EQUIPMENT SYMBOLS					IDENTIFICATION LETTERS						
LOCATION AND ACCESSIBILITY	SHARED DISPLAY/SHARED CONTROL		COMPUTER SYSTEMS AND SOFTWARE	DISCRETE	PRIMARY CHOICE OR BASIC PROCESS CONTROL SYSTEM	ALTERNATE CHOICE OR SAFETY INSTRUMENTED SYSTEM									FIRST LETTERS		SUCCEEDING LETTERS				
	ABCD 12345	ABCD 12345			ABCD 12345	ABCD 12345									MEASURED OR INITIATING VARIABLE	VARIABLE MODIFIER	READOUT/PASSIVE FUNCTION	OUTPUT/ ACTIVE FUNCTION	FUNCTION MODIFIER		
	- LOCATED IN FIELD - NOT PANEL, CABINET, OR CONSOLE MOUNTED - VISIBLE AT FIELD LOCATION - NORMALLY OPERATOR ACCESSIBLE														A	ANALYSIS	ALARM				
	- LOCATED IN OR ON FRONT OF CENTRAL OR MAIN PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														B	BURNER, COMBUSTION	USER'S CHOICE	USER'S CHOICE	USER'S CHOICE		
	- LOCATED IN REAR OF CENTRAL OR MAIN PANEL - LOCATED IN CABINET BEHIND PANEL - NOT VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														C	CONDUCTIVITY		CONTROL	CLOSE		
	- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENCE, DIFFERENTIAL			DEVIATION	
- LOCATED IN REAR OF SECONDARY OR LOCAL PANEL - LOCATED IN FIELD CABINET - NOT NORMALLY OPERATOR ACCESSIBLE AT PANEL OR CONSOLE														E	VOLTAGE (EMF)	SENSOR, PRIMARY ELEMENT					
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														F	FLOW, FLOW RATE	RATIO					
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														G	USER'S CHOICE	GLASS, GAUGE, VIEWING DEVICE					
- LOCATED IN REAR OF SECONDARY OR LOCAL PANEL - LOCATED IN FIELD CABINET - NOT NORMALLY OPERATOR ACCESSIBLE AT PANEL OR CONSOLE														H	HAND				HIGH		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														I	CURRENT	INDICATE					
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														J	POWER	SCAN					
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														K	TIME, SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														L	LEVEL	LIGHT			LOW		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE, INTERMEDIATE		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														N	TORQUE	USER'S CHOICE	USER'S CHOICE	USER'S CHOICE			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														O	USER'S CHOICE	ORIFICE, RESTRICTION		OPEN			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														P	PRESSURE	POINT (TEST CONNECTION)					
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														Q	QUANTITY	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE				
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														R	RADIATION	RECORD			RUN		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														S	SPEED, FREQUENCY	SAFETY		SWITCH	STOP		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														T	TEMPERATURE			TRANSMIT			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														W	WEIGHT, FORCE		WELL PROBE				
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														X	UNCLASSIFIED	X-AXIS	ACCESSORY DEVICES, UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														Y	EVENT, STATE, PRESENCE	Y-AXIS		AUXILIARY DEVICES			
- LOCATED IN OR ON FRONT OF SECONDARY OR LOCAL PANEL OR CONSOLE - VISIBLE ON FRONT OF PANEL OR ON VIDEO DISPLAY - NORMALLY OPERATOR ACCESSIBLE AT PANEL FRONT OR CONSOLE														Z	POSITION, DIMENSION	Z-AXIS, SAFETY INSTRUMENTED SYSTEM		DRIVER, ACTUATOR, INSTRUMENTED FINAL CONTROL ELEMENT			

**SUFFIX (X) TO DIFFERENTIATE BETWEEN INSTRUMENTS AND FUNCTIONS THAT WOULD OTHERWISE HAVE THE SAME IDENTIFICATION.**

**SINGLE INSTRUMENT OR OTHER COMPONENT HAVING MULTIPLE FUNCTIONS OR SHARING A COMMON HOUSING**

**DESIGNATIONS OF CONTROL FUNCTIONS (ZZZ) ASSOCIATED WITH INSTRUMENT OR OTHER COMPONENTS.**

AHC - AUTO/HOLD/CLOSE	OC - OPEN/CLOSE
AM - AUTO/MANUAL	OSC - OPEN/STOP/CLOSED
CALC - CALCULATION	POT - POTENTIOMETER
DEV - DEVIATION	RL - RAISE/LOWER
MOA - MANUAL/OFF/AUTO	RS - RUN/STOP
HOR - HAND/OFF/REMOTE	RSL - RAISE/STOP/LOWER
LOS - LOCKOUT STOP	SD - SHUTDOWN
LR - LOCAL/REMOTE	SEL - SELECT
LSR - LOCAL/STOP/REMOTE	SP - SET POINT
00 - ON / OFF	SR - START/RESET
	SS - STOP/START

**INSTRUMENT WITH COMPUTING OR CONVERTING FUNCTION**

**CONTROL SYSTEM COMPUTING FUNCTION**

**CONVERT**

E - VOLTAGE	H - HYDRAULIC
I - CURRENT	O - ELECTROMAGNETIC, SONIC
P - PNEUMATIC	R - RESISTANCE (ELECT.)
A - ANALOG	D - DIGITAL
B - BINARY	

**COMPUTE**

Σ - SUMMING	P - PROPORTIONAL	Δ - DIFFERENCE
- - SUBTRACTOR	R - DERIVATIVE	> - HIGH SELECTING
X - MULTIPLYING	Σ <sub>n</sub> - AVERAGING	< - LOW SELECTING
÷ - DIVIDING	:  - RATIO	∫ - INTEGRAL
√ - ROOT EXTRACTION	PID - PID	# - COMPLEX FUNCTION

# = 1, 2, 3, etc.  
REFER TO NOTE ON SAME SHEET FOR BRIEF DESCRIPTION

**ELECTRICAL CONTROL INTERLOCK**

**COMPLEX INTERLOCK**  
# = 1, 2, 3, etc.  
REFER TO NOTE ON SAME SHEET FOR BRIEF DESCRIPTION

**PILOT LIGHT**

**MISCELLANEOUS SYMBOLS**

DAMPER	QUICK CONNECT	BLIND FLANGE	FLEXIBLE HOSE	CALIBRATION CYLINDER	PULSATION DAMPENERS	EXPANSION TANK	HORN	HORN/STROBE	DIAPHRAGM SEAL	EQUIPMENT OR PANEL TAG	AIR FILTER/ MIST ELIMINATOR
VENTURI FLOW METER	VENT	DRAIN	RUPTURE DISK	DIAPHRAGM SEAL	FULL LINE OR TAPPED RING SEAL	MOTOR	FILTER	INJECTOR	STATIC MIXER		

**PRIMARY ELEMENT SYMBOLS**

MAGNETIC FLOW METER	SONIC FLOW METER	THERMAL MASS FLOW METER	TURBINE OR PROPELLER FLOW METER	VENTURI FLOW METER	AVERAGING PITOT TUBE	ROTAMETER WITH INTEGRAL VALVE	ULTRASONIC LEVEL SENSOR	NON-CONTACT RADAR LEVEL SENSOR	GUIDED WAVE RADAR LEVEL SENSOR	SUBMERSIBLE LEVEL SENSOR	FLOAT LEVEL SWITCH	CAPACITANCE LEVEL SENSOR
---------------------	------------------	-------------------------	---------------------------------	--------------------	----------------------	-------------------------------	-------------------------	--------------------------------	--------------------------------	--------------------------	--------------------	--------------------------

**ANALYTICAL ABBREVIATIONS**

(ZZZ) = ALK - ALKALINITY CH4 - METHANE CL2 - CHLORINE COMB - COMBUSTIBLE GAS CON - CONDUCTIVITY DO - DISSOLVED OXYGEN IR - INFRARED H2S - HYDROGEN SULFIDE LEL - LOWER EXPLOSIVE LIMIT METH - METHANOL VAPOR NH3 - AMMONIA NO3 - NITRATE O2 - OXYGEN O3 - OZONE ORP - OXIDATION/REDUCTION POTENTIAL	PETRO - PETROLEUM VAPOR PH - HYDROGEN ION CONCENTRATION PO4 - PHOSPHATE SO2 - SULFUR DIOXIDE TH - TOTAL HARDNESS TSS - TOTAL SUSPENDED SOLIDS TURB - TURBIDITY UV - ULTRAVIOLET
---	--

**GENERAL NOTES**

1. SYMBOLS AND NOMENCLATURE ARE BASED ON ANSI/ISA-5.1-2009.
2. REFER TO LEGEND SHEETS OF OTHER DISCIPLINES FOR ADDITIONAL SYMBOLS AND ABBREVIATIONS.
3. REFER TO SPECIFICATIONS FOR ADDITIONAL DETAIL ON CONTROL SYSTEM FUNCTIONAL REQUIREMENTS.
4. INSTRUMENTS AND PANELS DENOTED WITH AN ASTERISK (\*) ARE PROVIDED BY OTHER DISCIPLINES UNDER THIS CONTRACT. REFER TO THE DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL DETAIL.
5. POWER SUPPLIES FOR LOOPS OR SYSTEMS SHALL BE FURNISHED BY THE INSTRUMENTATION SUPPLIER TO MEET THE PARTICULAR CHARACTERISTICS (E.G., VOLTAGE AND CURRENT REQUIREMENTS) OF COMPONENTS IN EACH LOOP OR SYSTEM.


**LINE SYMBOLS AND LEGEND**

MAJOR PROCESS PIPES OR CHANNELS	PROCESS/SIGNALS NOT CONNECTED (CROSSING)
SECONDARY PROCESS OR MECHANICAL CONNECTION	PROCESS/SIGNALS CONNECTED
AIR SUPPLY OR SIGNAL	OFF-SHEET CONNECTOR
ELECTRICAL SIGNAL/ COPPER CABLE	DISCRETE ELECTRICAL SIGNALS
DATA LINK OR INTERNAL SOFTWARE LINK	DISCRETE DIGITAL SIGNALS
FIBER OPTIC CABLE	ANALOG ELECTRICAL SIGNALS
CAT6 CABLE	ANALOG DIGITAL SIGNALS

REFER TO SYSTEM ARCHITECTURE SHEETS FOR LINE TYPES REPRESENTING OTHER MEDIA AND PROTOCOLS

PROJECT ENGINEER:	C. THUNHORST				
DESIGNED BY:	C. THUNHORST				
DRAWN BY:	T. ROSE				
CHECKED BY:	C. THUNHORST				
1	BID SET	10/2024	CNT		
REV	ISSUED FOR	DATE	BY		

BID SET



Hazen

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SUITE 130, SOUTH JORDAN, UT 84095

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SEWER IMPROVEMENT DISTRICT  
OGDEN, UT

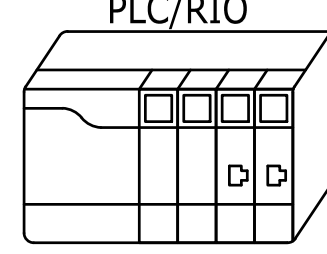
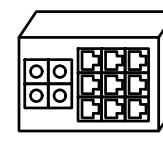


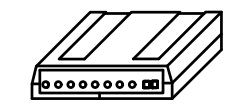
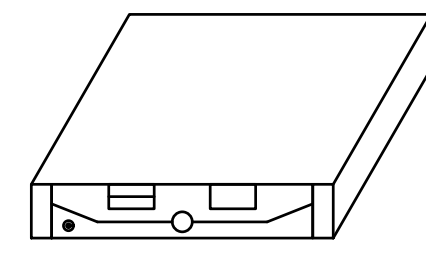
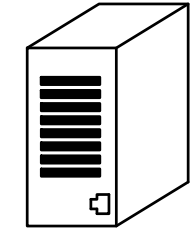
DEWATERING BUILDING HVAC  
IMPROVEMENTS

INSTRUMENTATION  
LEGENDS AND SYMBOLS

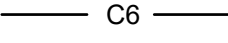

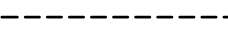
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HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	1001

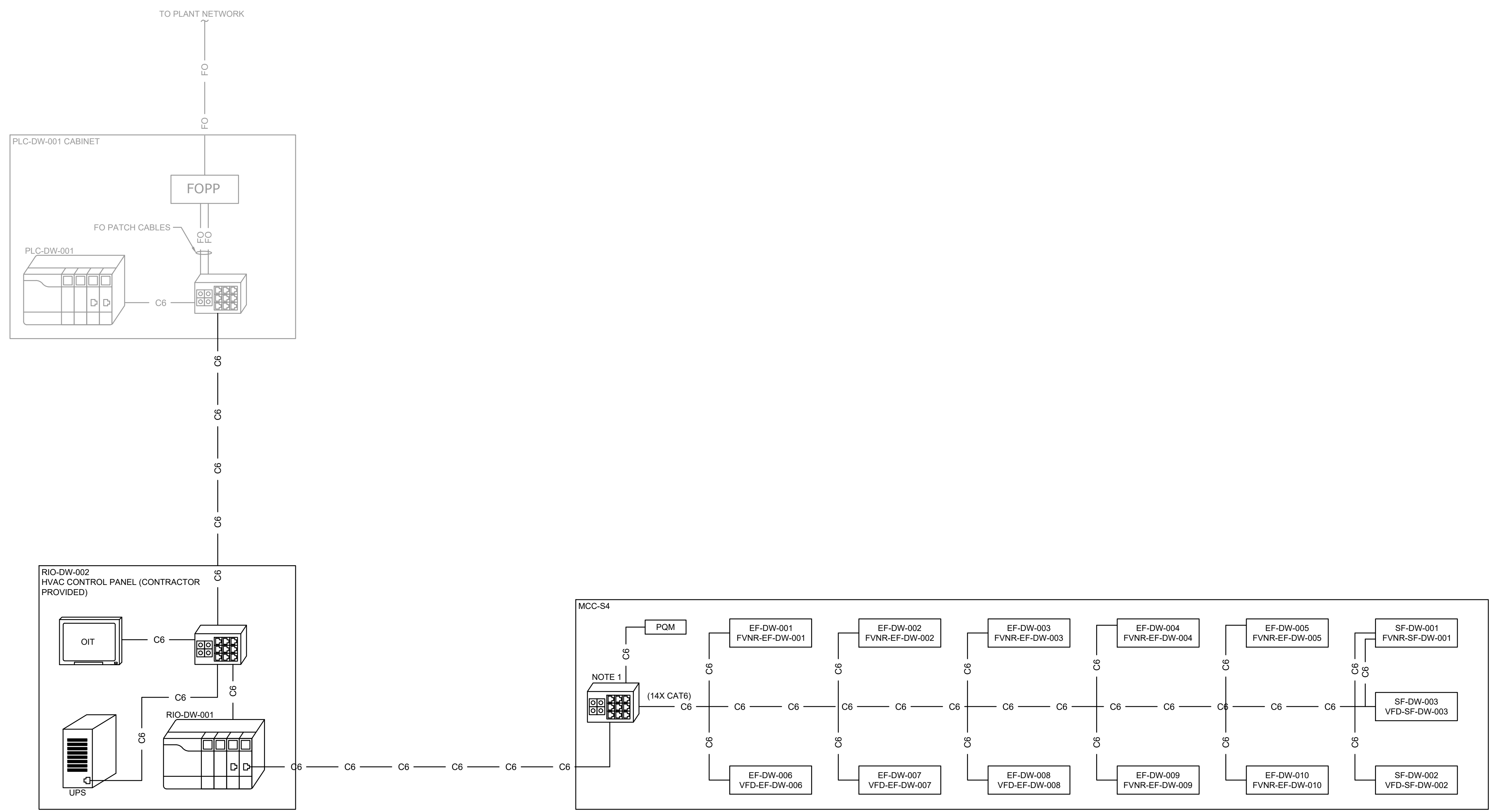
**NOTES:**  
 1. SWITCH BY MCC VENDOR, EXACT QUANTITY/CONFIGURATION TO BE DETERMINED BY VENDOR.

**SYMBOLS AND LEGEND**

	PLC (PROGRAMMABLE LOGIC CONTROLLER) / RIO (REMOTE INPUT-OUTPUT)
	ETHERNET SWITCH
	OIT (OPERATOR INTERFACE TERMINAL)
	FOPP (FIBER OPTIC PATCH PANEL)
	RADIO
	SERVER
	UNINTERRUPTIBLE POWER SUPPLY

**LINE TYPES**

	ETHERNET VIA CATEGORY 6 CABLE
	FIBER OPTIC CABLE
	SIGNAL WIRE



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DESIGNED BY:	C. THUNHORST
DRAWN BY:	T. ROSE
CHECKED BY:	C. THUNHORST
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	DATE
	CNT
	BY

BID SET



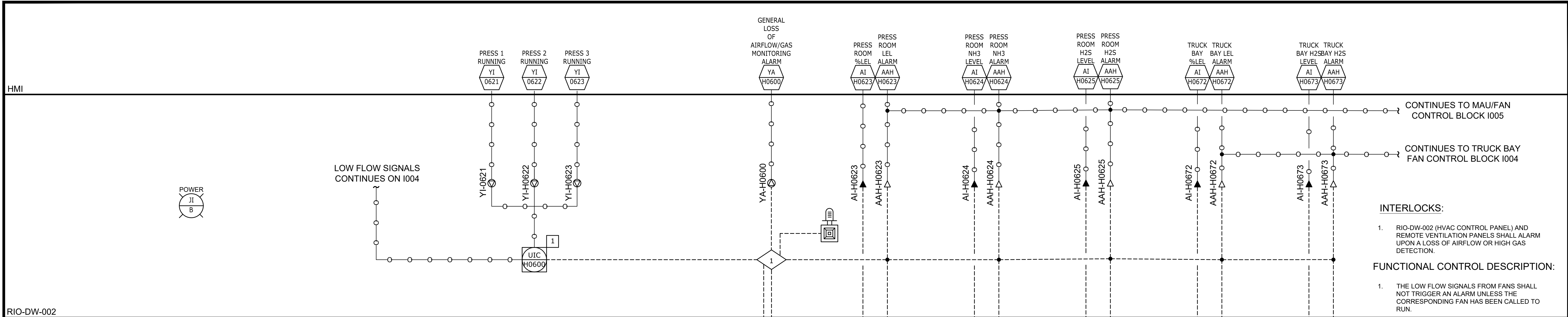
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 IMPROVEMENTS

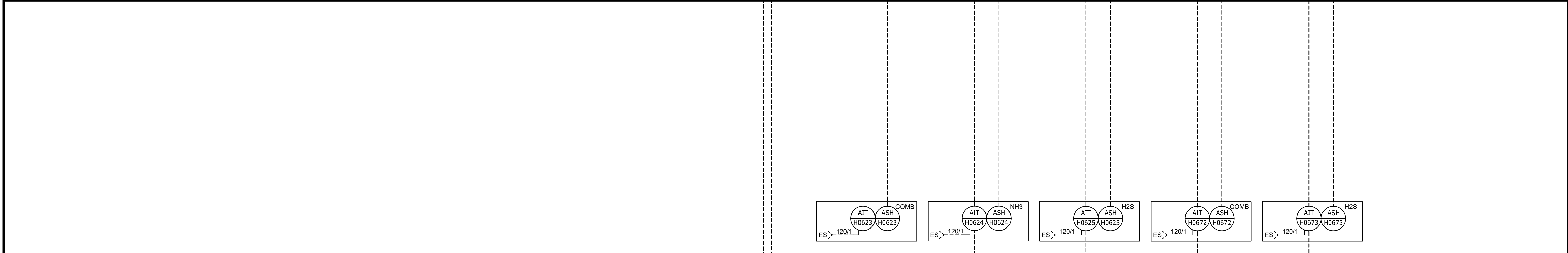
INSTRUMENTATION  
 NETWORK DIAGRAM

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	1002

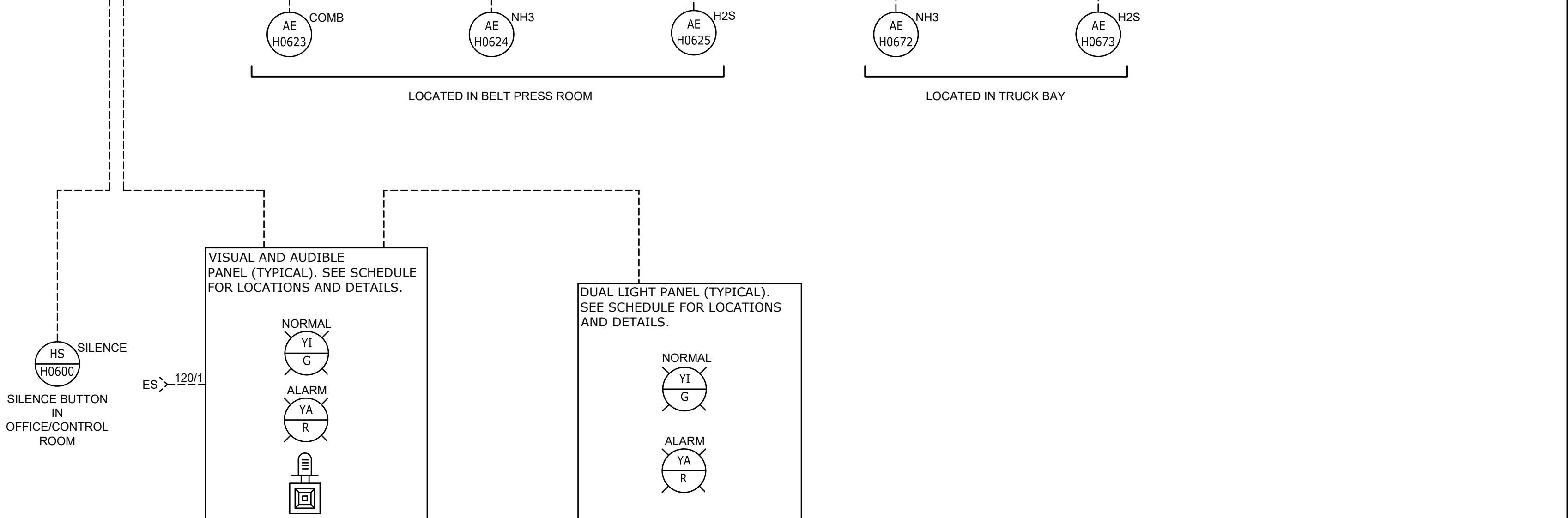




- INTERLOCKS:**
- RIO-DW-002 (HVAC CONTROL PANEL) AND REMOTE VENTILATION PANELS SHALL ALARM UPON A LOSS OF AIRFLOW OR HIGH GAS DETECTION.
- FUNCTIONAL CONTROL DESCRIPTION:**
- THE LOW FLOW SIGNALS FROM FANS SHALL NOT TRIGGER AN ALARM UNLESS THE CORRESPONDING FAN HAS BEEN CALLED TO RUN.



VENTILATION FAILURE PANEL (VFP) SCHEDULE					
DEVICE	LOCATION	TYPE	DEVICE	LOCATION	TYPE
RIO-DW-002	MECHANICAL MEZZANINE	HVAC CONTROL PANEL (VISUAL AND AUDIBLE)	VFP-DW-030	HVAC ROOM	VISUAL AND AUDIBLE
VFP-DW-020	BELT PRESS ROOM SOUTH WALL	VISUAL AND AUDIBLE	VFP-DW-031	COMPRESSOR ROOM	VISUAL AND AUDIBLE
VFP-DW-021	BELT PRESS ROOM WEST WALL	VISUAL AND AUDIBLE	VFP-DW-032	BELT PRESS ROOM EAST WALL	VISUAL AND AUDIBLE
VFP-DW-022	ELECTRICAL ROOM	VISUAL AND AUDIBLE	VFP-DW-033	ELECTRICAL ROOM SOUTH ENTRANCE	DUAL LIGHT
VFP-DW-023	PUMP ROOM EAST WALL	VISUAL AND AUDIBLE	VFP-DW-034	DEWATERING BUILDING SOUTH STAIRWELL ENTRANCE	DUAL LIGHT
VFP-DW-024	PUMP ROOM WEST WALL	VISUAL AND AUDIBLE	VFP-DW-035	CONTROL ROOM SOUTH ENTRANCE	DUAL LIGHT
VFP-DW-025	POLYMER CONTAINER AREA	VISUAL AND AUDIBLE	VFP-DW-036	TRUCK BAY SOUTHEAST ENTRANCE	DUAL LIGHT
VFP-DW-026	TOILET ROOM	VISUAL AND AUDIBLE	VFP-DW-037	TRUCK BAY NORTHEAST ENTRANCE	DUAL LIGHT
VFP-DW-027	LOCKER ROOM	VISUAL AND AUDIBLE	VFP-DW-038	DEWATERING BUILDING NORTH ENTRANCE	DUAL LIGHT
VFP-DW-028	OFFICE/CONTROL ROOM	VISUAL AND AUDIBLE	VFP-DW-039	DEWATERING BUILDING WEST ENTRANCE	DUAL LIGHT
VFP-DW-029	TRUCK BAY	VISUAL AND AUDIBLE			



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 PLOT DATE: 10/21/2024 9:00 AM BY: TROSE

PROJECT ENGINEER:	C. THUNHORST		
DESIGNED BY:	C. THUNHORST		
DRAWN BY:	T. ROSE		
CHECKED BY:	C. THUNHORST		
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"		
1	BID SET	10/2024	CNT
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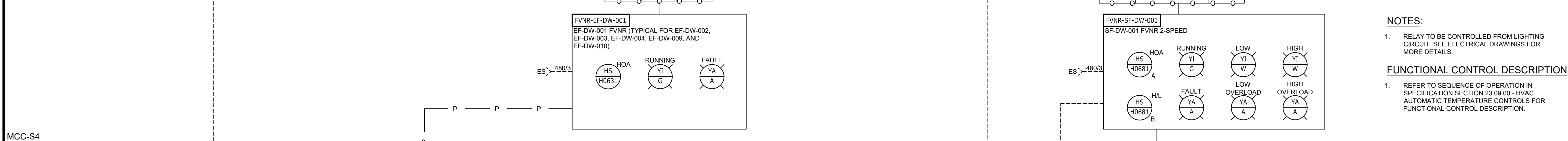
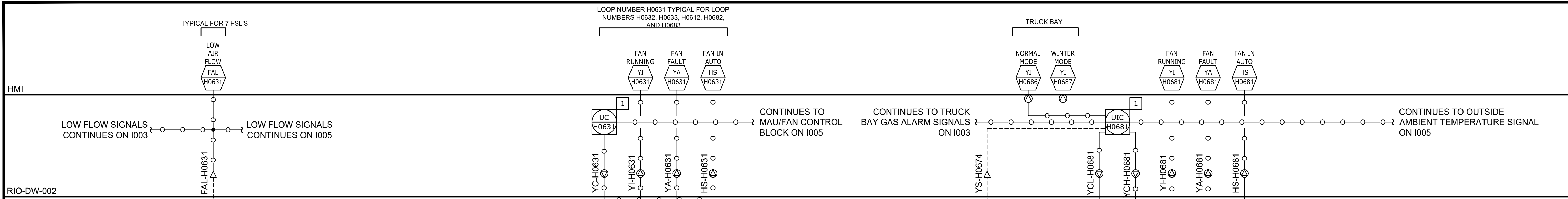
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OGDEN, UT

DEWATERING BUILDING HVAC IMPROVEMENTS

INSTRUMENTATION  
HVAC/GAS MONITORING SYSTEM

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CONTRACT NO.:	1
DRAWING NUMBER:	I003

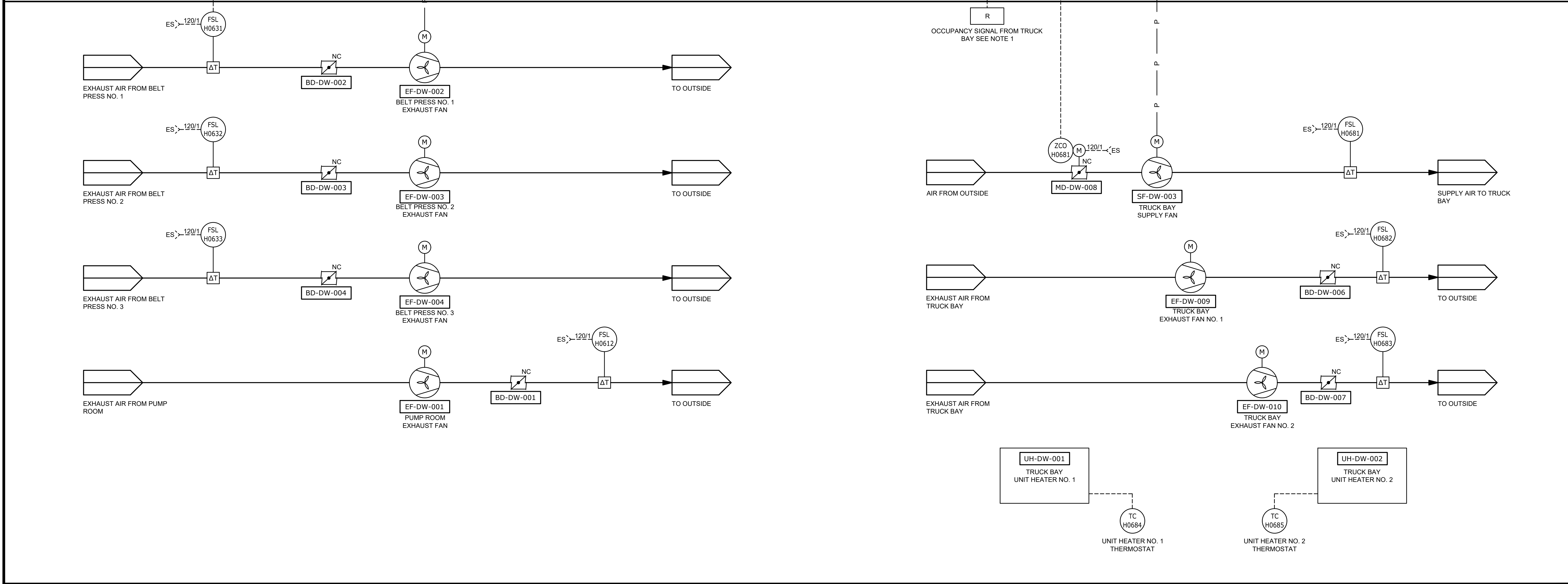


**NOTES:**

- RELAY TO BE CONTROLLED FROM LIGHTING CIRCUIT. SEE ELECTRICAL DRAWINGS FOR MORE DETAILS.

**FUNCTIONAL CONTROL DESCRIPTION:**

- REFER TO SEQUENCE OF OPERATION IN SPECIFICATION SECTION 23 09 00 - HVAC AUTOMATIC TEMPERATURE CONTROLS FOR FUNCTIONAL CONTROL DESCRIPTION.



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 DESIGNED BY: C. THUNHORST  
 DRAWN BY: T. ROSE  
 CHECKED BY: C. THUNHORST

BID SET

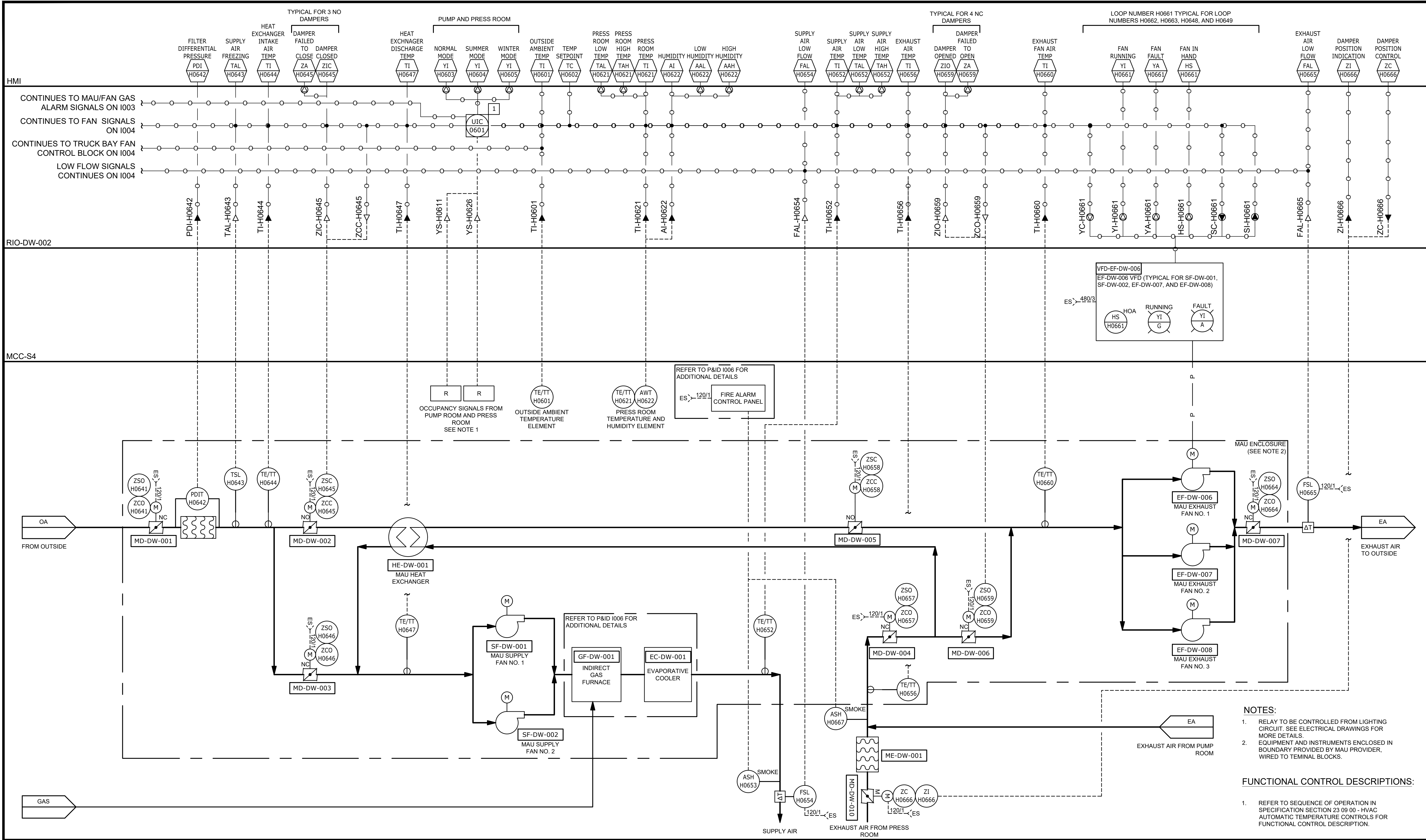
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 IMPROVEMENTS

INSTRUMENTATION  
 SUPPLY AND EXHAUST FANS P&ID

DATE: OCTOBER 2024  
 HAZEN NO.: 70123-000  
 CONTRACT NO.: 1  
 DRAWING NUMBER: I004





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DESIGNED BY:	C. THUNHORST
DRAWN BY:	T. ROSE
CHECKED BY:	C. THUNHORST

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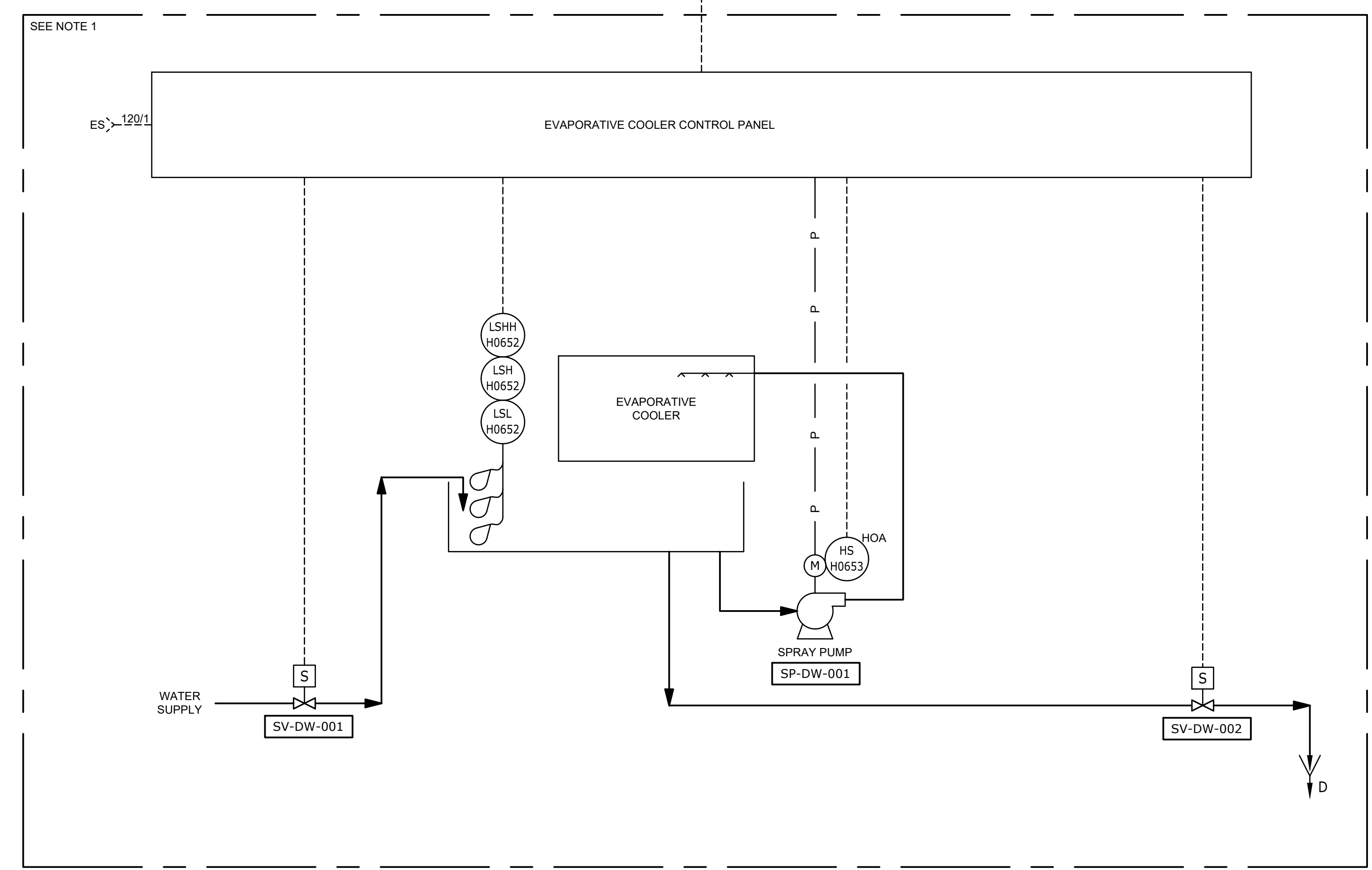
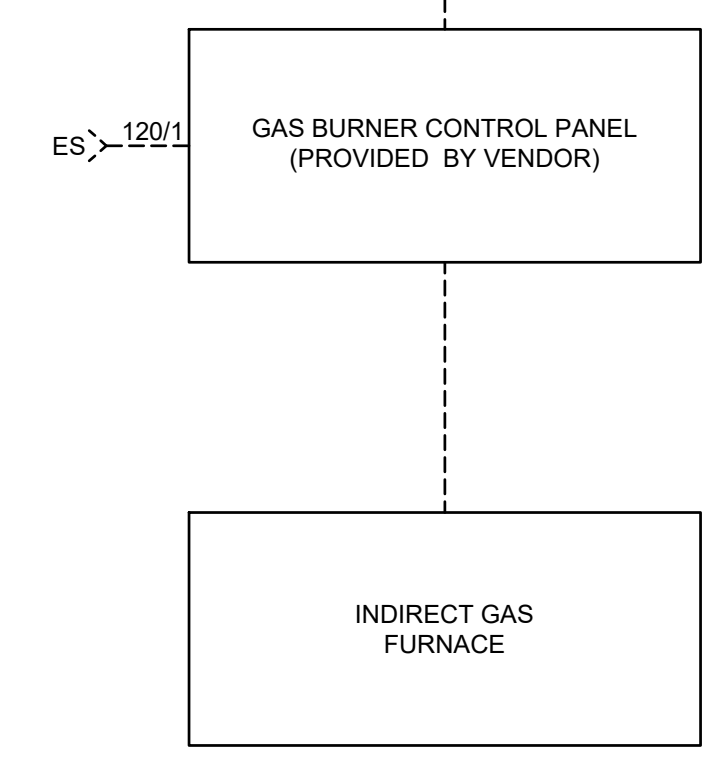
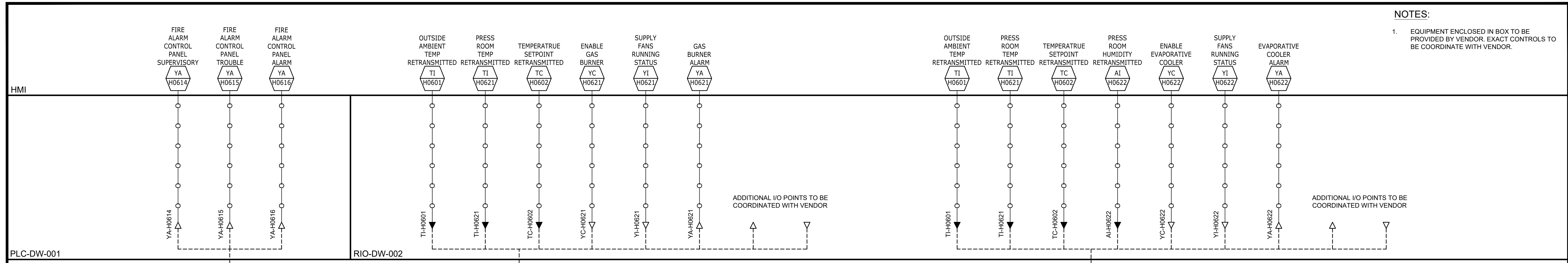
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OGDEN, UT  
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INSTRUMENTATION  
MAU P&ID

DATE:	OCTOBER 2024
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DRAWING NUMBER:	1005

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**NOTES:**  
 1. EQUIPMENT ENCLOSED IN BOX TO BE PROVIDED BY VENDOR. EXACT CONTROLS TO BE COORDINATE WITH VENDOR.



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PROJECT ENGINEER:	C. THUNHORST		
DESIGNED BY:	C. THUNHORST		
DRAWN BY:	T. ROSE		
CHECKED BY:	C. THUNHORST		
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"		
1	BID SET	10/2024	CNT
REV	ISSUED FOR	DATE	BY

BID SET

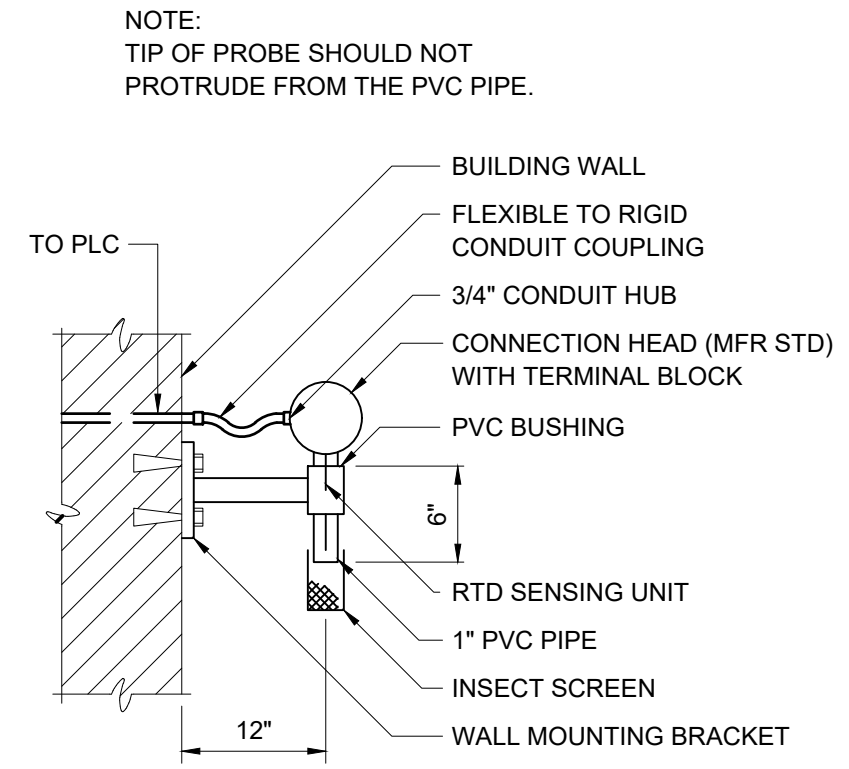
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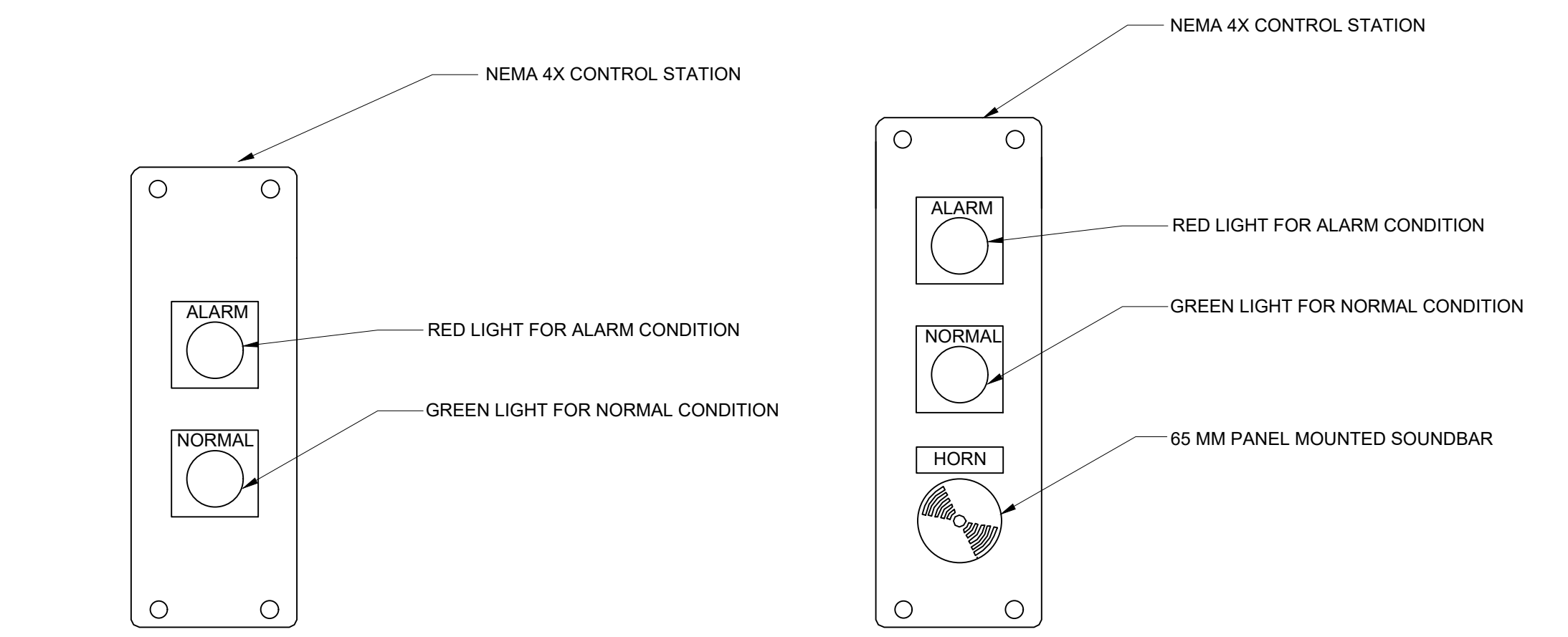
INSTRUMENTATION  
 GAS BURNER AND EVAPORATIVE COOLER P&ID

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HAZEN NO.:	70123-000
CONTRACT NO.:	1
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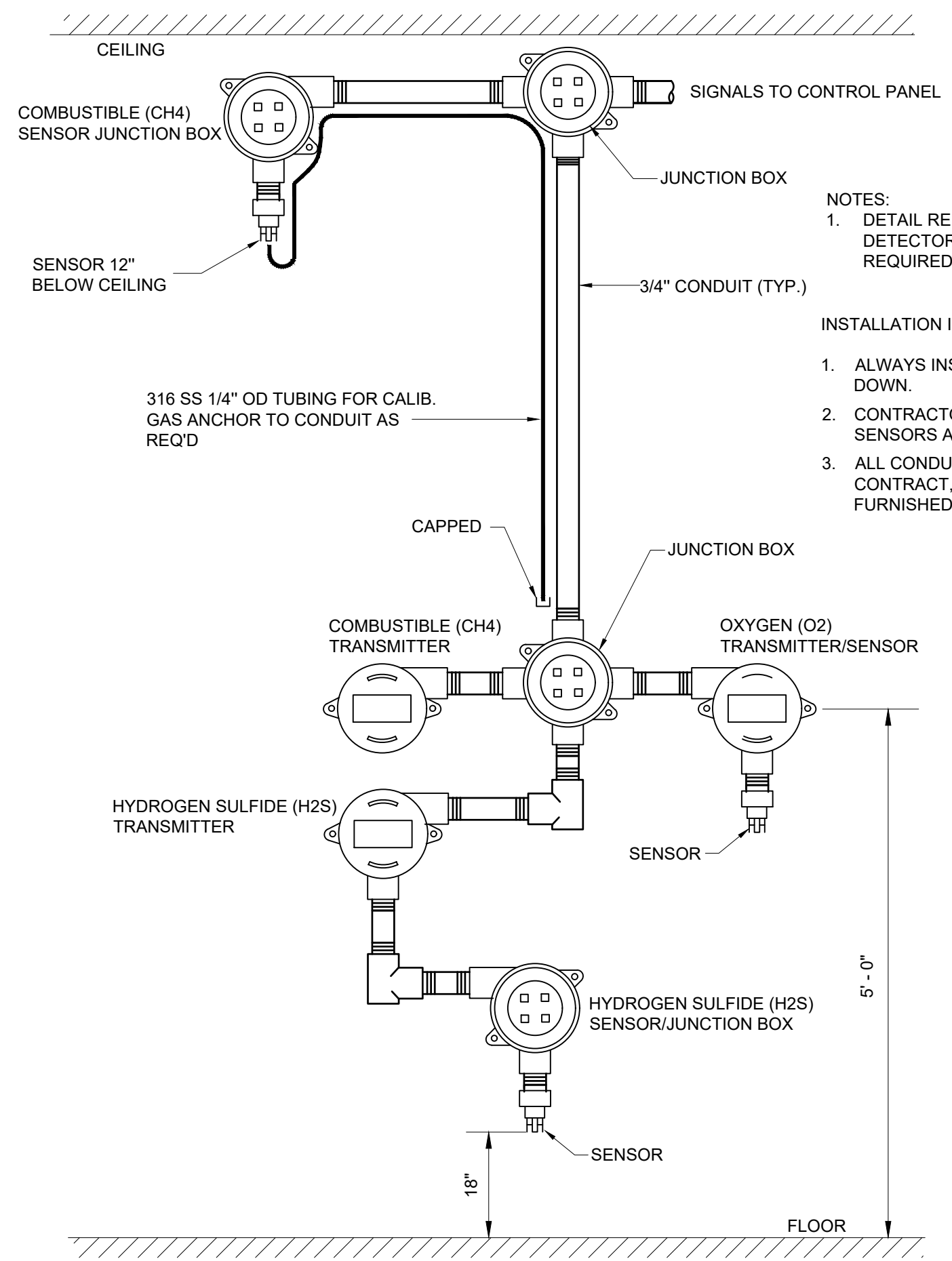




TYPICAL AMBIENT TEMPERATURE SENSING ELEMENT MOUNTED ON EXTERIOR WALL  
I-40-0402



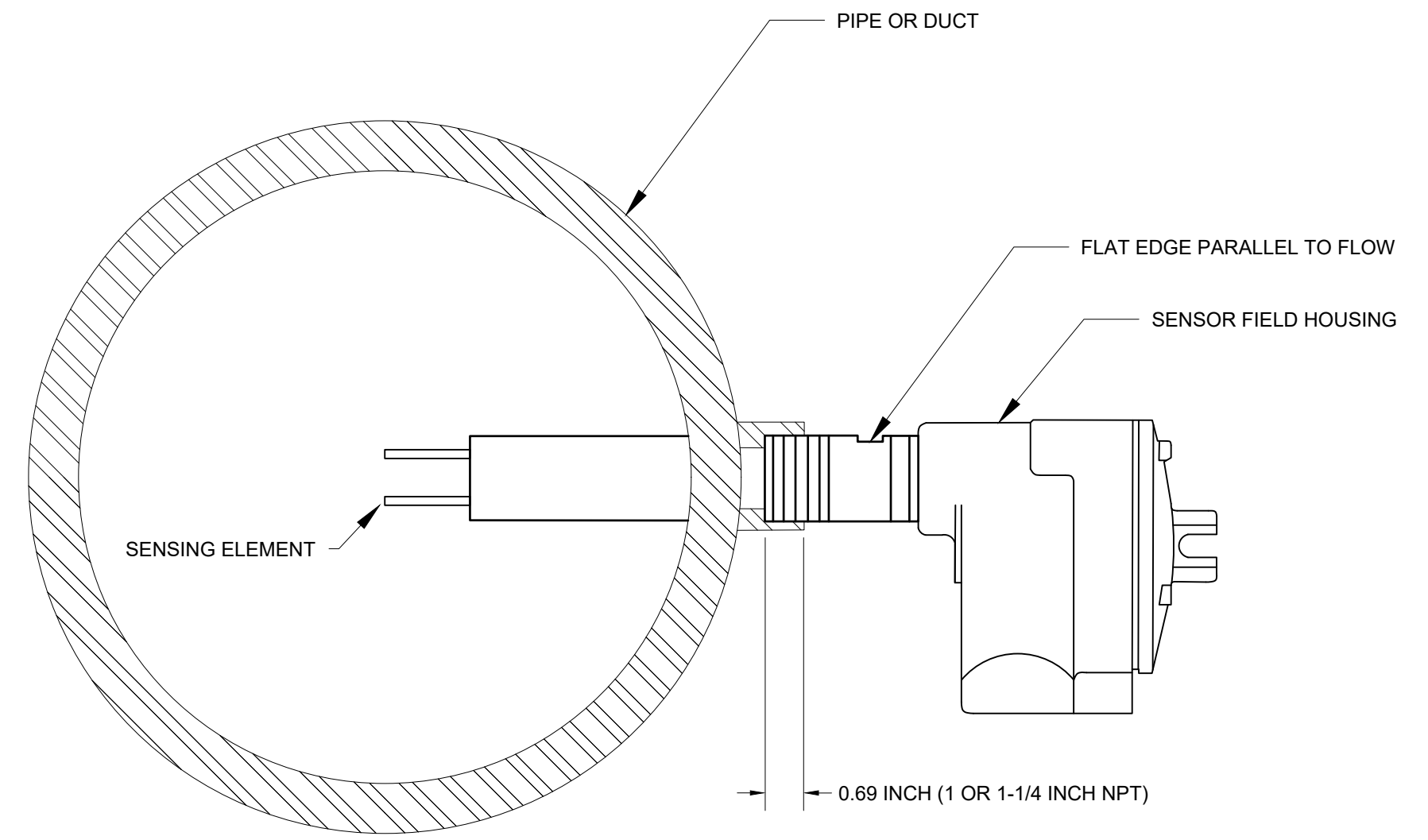
DUAL LIGHT WARNING SYSTEM  
VISUAL AND AUDIBLE ALARM  
VENTILATION FAILURE PANEL  
I-40-1020



NOTES:  
1. DETAIL REPRESENTS A TYPICAL INSTALLATION FOR GAS DETECTORS. REFER TO SPECIFICATIONS AND P&IDS FOR REQUIRED GAS DETECTORS.

INSTALLATION INSTRUCTIONS:  
1. ALWAYS INSTALL SENSOR WITH SENSING ELEMENT POINTING STRAIGHT DOWN.  
2. CONTRACTOR SHALL FURNISH AND INSTALL ALL JUNCTION BOXES, SENSORS AND TRANSMITTERS.  
3. ALL CONDUIT AND WIRING FURNISHED AND INSTALLED BY ELECTRICAL CONTRACT, EXCEPT CABLES BETWEEN SENSOR AND TRANSMITTER FURNISHED BY SENSOR MFR, INSTALLED BY ELECTRICAL CONTRACT.

GAS DETECTOR INSTALLATION  
I-40-0521



FLOW SWITCH INSTALLATION  
I-40-0805

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DRAWN BY:	T. ROSE
CHECKED BY:	C. THUNHORST
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0	1/2" 1"

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CENTRAL WEBER  
SEWER IMPROVEMENT DISTRICT  
OGDEN, UT  
  
DEWATERING BUILDING HVAC  
IMPROVEMENTS

INSTRUMENTATION  
STANDARD DETAILS

DATE:	OCTOBER 2024
HAZEN NO.:	70123-000
CONTRACT NO.:	1
DRAWING NUMBER:	I007