

CITY OF MOUNT CLEMENS, MICHIGAN
WASTEWATER TREATMENT PLANT BIOSOLIDS IMPROVEMENTS

Bid No. 022405

Contract Number 200-12747-23001

SRF NO. 5969-01

Bidding Documents
Project Manual
and
Drawings

Prepared by



TETRA TECH

Ann Arbor, Michigan

February 2024

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City of Mount Clemens

*One Crocker Boulevard
Mount Clemens, Michigan 48043*

**INVITATION TO BID
MOUNT CLEMENS, MICHIGAN
WASTEWATER TREATMENT PLANT BIOSOLIDS IMPROVEMENTS**

Bid No. 022405

Contract 200-12747-23001-S-1

SRF PROJECT NO. 5969-01

BID #022405

The City of Mount Clemens is accepting sealed bids for **WWTP BIOSOLIDS IMPROVEMENTS** until **WEDNESDAY, MARCH 6, 2024, at 2 p.m.** at the Purchasing Department, One Crocker Boulevard, Mount Clemens, Michigan 48043.

The City of Mount Clemens is now part of an organization called Michigan Inter-Governmental Trade Network (MITN), a group of agencies that joined forces to create a Regional Bid Notification System to notify companies of new bid opportunities partnering with IPT (Interactive Procurement Technologies) by BidNet. All bids, quotations and proposals are now being posted online. All vendors are encouraged to visit www.mitn.info in order to register their company and gain access to new bids and proposals. By selecting automatic bid notification, your company will receive e-mails anytime the City (and all other participating agencies) has a bid opportunity that matches your company's business. If you do not have internet access, please call 1-800-835-4603 and speak to a representative at Bid-Net.

The Work consists of the improvement to the Mount Clemens WWTP biosolids handling process including: installation of two new dewatering screw presses and conveyor system, replacement of sludge feed pumps, demolition of existing piping and equipment, and electrical and instrumentation improvements.

Bids shall be on a lump sum basis.

Bidding Documents may be obtained on or after February 5, 2024, through the Michigan Inter-governmental Trade Network (MITN) purchasing Group through the following website: <https://www.bidnetdirect.com/mitn>.

Equal Opportunity Employer

The Drawings and Project Manual under which the Work is to be done are on file and may be examined at the office of the Mount Clemens City Clerk, One Crocker Boulevard, Mount Clemens, MI 48043 and at the office of the ENGINEER, Tetra Tech, 1136 Oak Valley, Suite 100, Ann Arbor, MI 48108.

A Bid Security in the form of a certified check, bank check, or Bid Bond for a sum not less than five percent (5%) of the amount of the Bid will be required with each Bid.

The right is reserved by OWNER to accept any Bid, to reject any Bid, and to waive irregularities in Bids.

A mandatory Pre-Bid Conference will be held at 9:00 a.m. on February 12, 2024, at Mount Clemens WWTP, 1750 Clara Street, Mount Clemens, MI 48043. Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are required to attend either in person and participate in the conference and tour of the Site. Prospective Bidders who fail to attend and register at the meeting will be disqualified from bidding for the Work. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

OWNER will not engage in unlawful discrimination on the basis of race, color, religion, national origin, age, sex, height, weight, marital status, or unrelated disability.

This Contract is funded with a State Revolving Fund (SRF) loan. Bidders are required to complete the Certification Regarding Debarment, Suspension and other Responsibility Matters statement included in the Project Manual.

This Contract requires the use of prevailing wage rates. Other specific funding requirements are included in the Project Manual.

No Bids may be withdrawn after the above date and time for receiving Bids for a period of ninety (90) days.

Jillian Groulx
Purchasing Assistant

586-469-6800 x 319
586-469-7014 (fax)
jgroulx@mountclemens.gov

SECTION 00110 - CONTRACTOR'S QUALIFICATION STATEMENT

This Section shall be completed and submitted with the bid to demonstrate Bidder's qualifications to enter into Contract with and to perform the Work for OWNER.

1. Project Information:

OWNER: _____

Address: _____

Project: _____

Contract No. _____

2. Bidder Information:

Name of Organization: _____

Address: _____

Telephone: _____

Facsimile: _____

3. Surety company:

Name of Surety: _____

Agent's Name: _____

Surety Rating: _____ A.M. Best's Rating _____

Address: _____

Telephone: _____

Facsimile: _____

4. Type of Organization, check if:

Corporation Partnership Joint Venture Sole Proprietorship

If Corporation:

Date and State of Incorporation _____

List of Executive Officers

Name

Title

If Partnership:

Date and State of Organization: _____

Names of Current General Partners

Type of Partnership

General

Publicly Traded

Limited

Other (describe): _____

If Joint Venture:

Date and State of Organization: _____

Name, Address and Form of Organization of Joint Venture Partners: (Indicate managing partner by an asterisk *)

If Sole Proprietorship:

Date and State of Organization: _____

Name and Address of Owner or Owners

5. Completed Projects: In Schedule A, provide the following for projects completed within the past five years (If joint venture, list each participant's projects separately):
- A. List major engineered construction projects completed by this organization.
 - B. Has your organization ever failed to complete any work awarded to it?
 - C. Has your organization ever failed to substantially complete a project in a timely manner?
 - D. Are there any judgments, claims, arbitration proceedings or suits pending or outstanding against your organization or its officers?

- E. Has your organization filed any lawsuits or requested arbitration with regard to construction contracts?
- F. Has any Corporate officer, partner, joint venture participant or proprietor ever failed to complete a construction contract awarded to him or her in their own name or when acting as a principal of another organization?
- G. Is your organization a member of a controlled group of corporations as defined in I.R.C. Sec. 1563?
 Yes No

If yes, show names and addresses of affiliated companies.

- 6. Current Projects: In Schedule B, provide the following (If joint venture, list each participant's projects separately):
 - A. List major engineered construction projects under current contract by this organization.
 - B. Are there any projects that are beyond final completion date?
 - C. Are there any projects that have liquidated damages presently being assessed?
 - D. Are there any judgments, claims, arbitration proceedings or suits pending or outstanding against your organization or its officers?
 - E. Has your organization filed any lawsuits or requested arbitration on any of these projects?

7. Financial Resources:

- A. Provide complete financial statement for firm.
- B. Provide in Schedule C, equipment owned by firm. Include manufacturer's name, description, size and or capacity, and age.
- C. Provide the following information with respect to an accredited banking institution familiar with your organization.

Name of Bank: _____

Address: _____

Account Manager: _____

Telephone: _____

Facsimile: _____

D. What is your approximate total bonding capacity (circle one)?

\$30,000,000 to \$50,000,000

\$50,000,000 to \$100,000,000

\$100,000,000 or more

8. Experience Record: In Schedule D, provide:

A. Details of the construction experience of the principal individuals of your organization directly involved in construction operations.

B. Indicate general types of work performed with your own work force.

9. Safety: Describe the permanent safety program you maintain within your organization (use attachment if necessary).

A. Submit a copy of the Bidder's current Experience Modification Rates (EMR).

B. Submit Bidder's OSHA Form 200 recordable incidence rate for the last calendar year, per 200,000 man-hours, for:

1. Total cases.
2. Lost workday cases.
3. Non-fatal cases per number of lost workdays.

I hereby certify that the information submitted herewith, including any attachment is true to the best of my knowledge and belief.

Subscribed and sworn to
before me on _____

County, Michigan

By: _____

Title: _____

Dated: _____

Signature _____

Printed: _____

Notary Public

COMPLETED PROJECTS

SCHEDULE A

Name, Location, and Description of Project	Owner	Design Engineer	Date Completed	Contract Price	5.B. Yes / No	5.C. Yes / No	5.D. Yes / No	5.E. Yes / No	5.F. Yes / No	Reference/Contact Include Address & Phone

If any of questions 5.B. through F is yes, then attach written explanation.

CURRENT PROJECTS

SCHEDULE B

Name, Location, and Description of Project	Owner	Design Engineer	Date Completed	Contract Price	6.B. Yes / No	6.C. Yes / No	6.D. Yes / No	6.E. Yes / No	Reference/Contact Include Address & Phone

If any of questions 6.B. through E is yes, then attach written explanation.

FINANCIAL RESOURCES

SCHEDULE C

Owned Equipment Description	Manufacturer's Name	Size or Capacity	Age	Condition	Location Stored

EXPERIENCE RECORD

SCHEDULE D

Person's Name	Position	Date started with this Firm	Year started in Construction	Prior positions and experience in Construction

General Types of Work Performed by Own Work Force: _____

SECTION 00200 - INSTRUCTION TO BIDDERS

ARTICLE 1 - DEFINED TERMS

- 1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the Contract Documents. Additional terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and plural thereof:
- A. *Bidder*: The individual or entity who submits a Bid directly to OWNER.
 - B. *Issuing Office*: The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
 - C. *Successful Bidder*: The lowest responsible Bidder submitting a responsive Bid to whom OWNER (on the basis of OWNER's evaluation as hereinafter provided) makes an award.

ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

- 2.01 Complete sets of the Bidding Documents for the purchase sum, if any, stated in the Advertisement or Invitation to Bid may be obtained from the Issuing Office.
- 2.02 Complete sets of Bidding Documents must be used in preparing Bids; neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 2.03 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 confer a license or grant for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

- 3.01 Each Bidder shall submit to ENGINEER the following information pertaining to its financial resources, adequacy of plant and equipment, organization, prior experience and other facts, as their qualification to enter into contract with and to perform the Work for OWNER.
- A. Section 00110 - Contractor's Qualification Statement, including Schedules A, B, C, and D.
 - B. Bidders must demonstrate in Schedule A, a minimum of five project experiences within the last ten years that are similar to or larger than this Project. Projects must be similar in nature to this Project description. Bidders who cannot demonstrate project experience of this type or size must demonstrate an experience in other types of construction projects of comparable complexity.
 - C. Article 3 documents are due by the date specified in the advertisement for bids.

ARTICLE 4 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

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

- A. To examine and carefully study the Bidding Documents, including any Addenda and other related data identified in the Bidding Documents (including "technical data" referred to in Paragraphs 4.02 through 4.05, inclusive);
- B. To 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. To become familiar with and satisfy Bidder as to all Federal, State, and local Laws and Regulations that may affect cost, progress, and performance of the Work;
- D. To promptly notify ENGINEER of all conflicts, errors, ambiguities, or discrepancies which Bidder has discovered in or between the Contract Documents and such other related documents;
- E. To carefully study all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the General Conditions, and carefully study all reports and drawings of a Hazardous Environmental Condition, if any, at the Site which have been identified in the General Conditions;
- F. To obtain and carefully study (or assume responsibility for doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto;
- G. To 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 performance of the Work at the price bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;
- H. To correlate the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents;
- I. To determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work;

4.02 Subsurface and Physical Conditions

- A. The Contract Documents identify:
 - 1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that ENGINEER has used in preparing the Bidding Documents.
 - 2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that ENGINEER has used in preparing the Bidding Documents.
- B. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated conditions appear in Article 5 of the General Conditions.

4.03 Underground Facilities

- 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.

4.04 Hazardous Environmental Condition(s)

- A. The General Conditions identify:
 - 1. Those reports and drawings relating to Hazardous Environmental Condition(s) identified at the Site, if any, that ENGINEER has used in preparing the Bidding Documents are identified in Article 5 of the General Conditions and the Appendix to the Project Manual.
- B. Bidder acknowledges existing reports of hazardous environmental conditions and shall base its bid on the information contained therein and in the Contract Documents. Bidder is responsible for any interpretation or conclusion Bidder draws from any “technical data” or any other data, interpretations, opinions, or information contained in such reports or shown or indicated on such drawings.

4.05 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of the Contract Documents, that without exception the Bid is premised upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and 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 and furnishing the Work.

ARTICLE 5 - PRE-BID CONFERENCE

5.01 A mandatory Pre-Bid Conference will be held at 9:00 a.m. on February 12, 2024, at Mt. Clemens WWTP, 1750 Clara Street, Mt. Clemens, MI 48043. Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are required to attend either in person and participate in the conference and tour of the Site. Prospective Bidders who fail to attend and register at the meeting will be disqualified from bidding for the Work. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 6 - SITE AND OTHER AREAS

6.01 The Site is identified 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 in Work are to be obtained and paid for by CONTRACTOR. 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.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

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

7.02 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by OWNER or ENGINEER.

ARTICLE 8 - BID SECURITY

8.01 A Bid must be accompanied by Bid Security made payable to OWNER in an amount of five percent of Bidder's maximum Bid price and in the form of a certified check, bank check, or a Bid Bond on the form attached in Section 00430, issued by a surety meeting the requirements of the Contract Documents.

8.02 The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required Contract Security and met the other conditions of the Notice of Award, whereupon the Bid Security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required Contract Security within ten (10) days after the Notice of Award, OWNER may annul the Notice of Award and the Bid Security of that Bidder will be forfeited. The Bid Security of other Bidders whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of seven (7) days after the Effective Date of the Agreement or 91 days after the Bid opening, whereupon Bid Security furnished by such Bidders will be returned.

8.03 Bid Security of other Bidders whom OWNER believes do not have a reasonable chance of receiving the award will be returned within seven (7) days after the Bid opening.

ARTICLE 9 - CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be (a) Substantially Completed, (b) Milestones (if any), and (c) also completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 - LIQUIDATED DAMAGES

10.01 Provisions for liquidated damages, if any, are set forth in the Agreement, Section 01110 and other 01 sections.

ARTICLE 11 - SUBSTITUTE AND "OR-EQUAL" ITEMS

11.01 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 acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by CONTRACTOR and consideration by ENGINEER is set forth in the General Conditions and may be supplemented in the General Requirements.

ARTICLE 12 - SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 If the Contract Documents 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 provide with Bid Form at opening, submit to OWNER a list of all such Subcontractors, Suppliers, individuals, or 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 qualification for each such Subcontractor, Supplier, individual, or entity if requested by OWNER.

12.02 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, 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 7.06 of the General Conditions.

12.03 CONTRACTOR shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom CONTRACTOR has reasonable objection.

12.04 The manufacturers of certain equipment items are required to submit Equipment Data Sheets to ENGINEER prior to the time Bids are received. Equipment items requiring such submittals are identified in the Specifications. Failure on the part of the manufacturer to provide this information in the form and at the time prescribed in the individual Specification Sections where the equipment is described will make their equipment subject to rejection by OWNER.

ARTICLE 13 - PREPARATION OF BID

13.01 The Bid Form is included with the Bidding Documents. Additional copies may be obtained from ENGINEER or Issuing Office.

City of Mt Clemens

WWTP Biosolids Improvements

200-12747-23001

00200-5

12/15/2023

- 13.02 All blanks on Bid Form shall be completed by printing in ink or by typewriter and the Bid signed. Changes on Bid Form shall be lined-out with Bidder's initials next to the change to signify and validate change on Bid Form.
- 13.03 A Bid by a corporation shall be executed in the corporate name by the president or a vice-president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown below the signature.
- 13.04 A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown below the signature.
- 13.05 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 must be shown below the signature.
- 13.06 A Bid by an individual shall show the Bidder's name and official address.
- 13.07 A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on Bid Form. The official address of the joint venture must be shown below the signature.
- 13.08 Evidence of authority to conduct business as an out-of-state corporation in the state where the Work is to be performed shall be provided in accordance with Paragraph 13.03 above. State contractor license number, if any, must be shown.
- 13.09 All names shall be typed or printed in black ink below the signatures.
- 13.10 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on Bid Form.
- 13.11 The address and telephone number for communications regarding the Bid shall be shown.
- 13.12 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the Contract. Bidder's state contractor license number for the state of the Project, if any, shall also be shown on Bid Form.

ARTICLE 14 - BASIS OF BID; EVALUATION OF BIDS

14.01 Lump Sum

- A. Bidders shall submit a Bid on a Lump Sum basis as set forth on Bid Form.

14.02 The Bid price shall include cash allowances, if any, named in the Contract Documents.

14.03 The Bidder will complete the "EQUIPMENT EVALUATION" portion of the Bid. OWNER reserves the right to evaluate the data and prices received for the products listed. Based on the information listed on "Equipment Data Sheet" included in the appropriate Specification Section and the prices listed on Bid Form, OWNER will evaluate the product as to its long-term value. If OWNER determines that another product is desirable to OWNER, a Change Order, in accordance with Articles 10, 11, and 12 of the

City of Mt Clemens

WWTP Biosolids Improvements

200-12747-23001

00200-6

12/15/2023

General Conditions, will be issued for providing the product at the differential price listed on Bid Form after the award of the Contract.

ARTICLE 15 - SUBMITTAL OF BID

15.01 Each prospective Bidder is furnished one copy of the Bidding Documents. An unbound copy of Bid Form is to be completed and submitted with the following data:

- A. Evidence of Bidder's qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the Contract; and
- B. Required Bid Security in the form of a certified check, bank check, or a Bid Bond; and
- C. Section 00435 - A tabulation of Subcontractors, Suppliers and other individuals and entities required to be identified in this Bid.
- D. Information required of the SRF loan administrator including certification regarding debarment and Good Faith Efforts Worksheets.
- E. Certification of Compliance with Iran Economics Sanction Act.

15.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the Advertisement or Invitation to Bid and shall be enclosed in an opaque sealed envelope plainly 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 Bidder, and shall be accompanied by the Bid Security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid shall be addressed to OWNER's office.

ARTICLE 16 - MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be modified or 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 for the opening of Bids.

16.02 No Bidder may withdraw any Bid after the time stated in the Advertisement or Invitation to Bid.

ARTICLE 17 - OPENING OF BIDS

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

ARTICLE 18 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 19 - AWARD OF CONTRACT

- 19.01 OWNER reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. OWNER further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be non-responsible. OWNER may also reject the Bid of any Bidder if OWNER believes that it would not be in the best interest of the Project to make an award to that Bidder. OWNER also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate Contract terms with the Successful Bidder.
- 19.02 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.
- 19.03 In evaluating Bids, OWNER will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested on Bid Form or prior to the Notice of Award.
- 19.04 In evaluating Bidders, OWNER will consider the qualifications of Bidders, in accordance with Article 3 of this Section, and 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 Contract Documents.
- 19.05 OWNER may conduct such investigations as OWNER deems necessary to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities to perform the Work in accordance with the Contract Documents.
- 19.06 If the Contract is to be awarded, OWNER will award the Contract to the Bidder whose Bid is in the best interests of the Project.

ARTICLE 20 - CONTRACT SECURITY AND INSURANCE

- 20.01 Article 5 of the General Conditions, as may be modified by the Contract Documents, sets forth OWNER's requirements as to performance and payment Bonds and insurance. When the Successful Bidder delivers the executed Agreement to OWNER, it must be accompanied by such Bonds and insurance.

ARTICLE 21 - SIGNING OF AGREEMENT

- 21.01 When OWNER gives a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents which are identified in the Agreement as attached thereto. Within ten (10) days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to OWNER. Within ten (10) days thereafter, OWNER shall deliver one fully signed counterpart to Successful Bidder with a complete set of Drawings with appropriate identification.

ARTICLE 22 - SALES AND USE TAXES

- 22.01 Bidder shall pay all State Sales, Use, and other Taxes that are lawfully assessed against OWNER or Bidder on materials and equipment to be incorporated in Work. Said taxes shall be included in the Contract Price. Refer to General Conditions Article 13.

ARTICLE 23 - RETAINAGE

23.01 Provisions concerning CONTRACTOR's retainage are set forth in Section 00615.

END OF SECTION

SECTION 00400 - BID FORM

CITY OF MOUNT CLEMENS, MICHIGAN

WASTEWATER TREATMENT PLANT

BIOSOLIDS IMPROVEMENTS

Contract 200-12747-23001-S-1

BID NO. 022405

SRF PROJECT NO. 5969-01

THIS BID IS SUBMITTED TO:

City of Mount Clemens
 Owner
One Crocker Boulevard
 Address
Mount Clemens, MI 48043
 City, State, Zip

- 1.01 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.
- 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 security. The Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of OWNER.
- 3.01 In submitting this Bid, Bidder represents, as set forth in the Agreement, that:

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

<u>Addendum No.</u>	<u>Addendum Date</u>
_____	_____
_____	_____
_____	_____

- B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. Bidder is familiar with and is satisfied as to all Federal, State, and local Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Bidder has carefully studied all:

1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) as provided in Paragraph 5.03 of the General Conditions, and
 2. Reports and drawings of a Hazardous Environmental Condition, if any, which has been identified as provided in Paragraph 5.06 of the General Conditions.
- E. Bidder has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder, and safety precautions and programs incident thereto.
- F. Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.
- G. Bidder is aware of the general nature of Work to be performed by OWNER and others at the Site that relates to the Work as indicated in the Bidding Documents.
- H. Bidder has correlated the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.
- I. Bidder has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by ENGINEER is acceptable to Bidder.
- J. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.
- K. In preparation of this Bid, Bidder acknowledges that it will not discriminate against any employee or applicant for employment with respect to hire, tenure, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of race, color, religion, national origin, age, sex, height, weight, marital status, or a disability that can be reasonable accommodated. OWNER will require this covenant be placed in the Contract with any subcontractor employed in the performance of this Contract.
- L. OWNER will utilize funds from the State Revolving Loan Fund (SRF) on the Project. Bidders acknowledge that they must:
1. Revolving Loan Fund projects require the use of Prevailing Wages as explained in Section 00450.
 2. Revolving Loan Fund projects require the use of American Iron & Steel Contract requirements as explained in Section 00458.

3. Complete the Certification Regarding Debarment, Suspension and Other Responsibility Matters form in Section 00450, or explanation why it cannot certify the terms included in the certification, within seven (7) days after a request from OWNER.
 - a. In addition, each prospective subcontractor and supplier must submit a completed certification or explanation to CONTRACTOR for all procurement transactions of \$25,000 or more. The submission of the certification or explanation is also required for all sub-tier subcontractors.

M. All claims and disputes arising from related Work at Site by other contractors shall be settled in accordance with Article 12 of the General Conditions.

4.01 Bidder further represents that this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any individual or entity to refrain from bidding; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over OWNER.

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

A. BASE BID PRICE _____
(use words)

(\$ _____)
(figures)

B. All specific allowances are included in the price(s) set forth above and have been computed in accordance with Paragraph 13.02 of the General Conditions.

C. Alternates for this Contract are set forth in Section 01230. The price for each Alternate will be the amount added to or deleted from the base Bid if OWNER selects the Alternate. Alternates will be applied in the order as they appear below:

1. Alternate 1:

Alternate No. 1 generally consists of deleting the demolition of existing equipment and sludge piping in Solids Building basement.

(deduct) _____ (\$ _____)
words figures

2. Alternate 2:

Alternate No. 2 generally consists of deleting the demolition of the existing aeration diffusers, piping and submersible mixers from the sludge storage tanks.

(deduct) _____ (\$ _____)

words

figures

3. Alternate 3:

Alternate No. 3 generally consists of deleting the proposed floor coating in the Solids Building garage area.

(deduct) _____ (\$_____)

words

figures

D. Unit Price Adjustments to the Lump Sum Bid Price for this Contract are set forth in the Specifications. Some of the work below has been included in the Lump Sum Bid Price. If additions to these quantities occur, the Contract Price will be adjusted by Change Order on the basis of the following:

Item and Location in Specifications	Unit for Adjustment	Included in Base Bid	Adjustment Price Per Unit
Concrete Surface Repair (03930) Less than 2-inch Depth	Square Foot	200 SF	\$
Concrete Surface Repair (03930) Greater than 2-inch Depth	Square Foot	100 SF	\$
Concrete Crack Epoxy Resin Injection (03930)	Lineal Foot	100 LF	\$

1. Adjustment prices are subject to acceptance by OWNER, and rejections of one or more adjustment prices will not invalidate acceptance of this Bid.

E. All specific allowances are included in the price(s) set forth above and have been computed in accordance with Paragraph 13.02 of the General Conditions.

6.01 Equipment Evaluation. OWNER reserves the right to evaluate the "EQUIPMENT EVALUATION" data and prices received for the products listed below in accordance with Paragraphs 14.04 and 19.07 of the Instructions to Bidders.

Section	Equipment Item	Manufactured By	Price
11311	Positive Displacement Pumps		\$
16422	Variable Frequency Drives		\$

7.01 CONTRACTOR shall list subcontractors proposed for the following Work.

Division 3	Concrete Subcontractor	_____
	Demolition	_____
Division 9	Painting Subcontractor	_____
Division 13	Instrumentation Subcontractor	_____
Division 15	Process Piping and Equipment Subcontractor	_____
Division 16	Electrical Subcontractor	_____

8.01 Bidder agrees that the Work will be substantially completed and completed and ready for final payment in accordance with Paragraph 15.03 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

9.01 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the times specified above, which shall be stated in the Agreement.

10.01 The following documents are attached to and made a condition of this Bid:

- A. Evidence of Bidder's qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the Contract; and
- B. Required Bid Security in the form of a certified check, bank check, or a Bid Bond; and
- C. Section 00435 - A tabulation of Subcontractors, Suppliers and other individuals and entities required to be identified in this Bid.

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

SUBMITTED on _____, 20____.

State Contractor License No. _____ (If applicable)

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____ (SEAL)

(Individual's signature)

Doing business as: _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____

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

Name (typed or printed): _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

Type (General Business, Professional, Service, Limited Liability): _____

By: _____

(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(CORPORATE SEAL)

Attest _____

(Signature of Corporate Secretary)

Business address: _____

Phone No.: _____ FAX No.: _____

Date of Qualification to do business is _____

A Joint Venture

Joint Venturer Name: _____ (SEAL)

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

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

Joint Venturer Name: _____ (SEAL)

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

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

Phone and FAX Number, and Address for receipt of official communications:

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

END OF SECTION

BID BOND

BIDDER (Name and Address):

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

OWNER (Name and Address):

BID

BID DUE DATE: _____

PROJECT (Brief Description Including Location):

BOND

BOND NUMBER: _____

DATE (Not later than Bid due date): _____

PENAL SUM: _____ (Words) _____ (Figures)

IN WITNESS WHEREOF, Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER

SURETY

_____(Seal)

_____(Seal)

Bidder's Name and Corporate Seal

Surety's Name and Corporate Seal

By: _____
Signature and Title

By: _____
Signature and Title
(Attach Power of Attorney)

Attest: _____
Signature and Title

Attest: _____
Signature and Title

- Note: (1) Above addresses are to be used for giving required notice.
(2) Any singular reference to Bidder, Surety, OWNER or other party shall be considered plural where applicable.

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.

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

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

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

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses

shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power or 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 00450 - CLEAN WATER STATE REVOLVING FUND AND
DRINKING WATER REVOLVING FUND

American Iron and Steel Contract Language

The Contractor acknowledges to and for the benefit of the City of Mt. Clemens (“Owner”) and the Michigan Department of Environment, Great Lakes, and Energy (the “Funding Authority”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or the Drinking Water State Revolving Fund and such laws contain provisions commonly known as “American Iron and Steel (AIS);” that requires all iron and steel products used in the project be produced in the United States (“AIS Requirements”) including iron and steel provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the AIS Requirements, (b) all iron and steel used in the project will be and/or have been produced in the United States in a manner that complies with the AIS Requirements, unless a waiver of the requirements is approved or the State made the determination in writing that the AIS Requirements do not apply to the project, and (c) the Contractor will provide any further verified information, certification, or assurance of compliance with this paragraph, or information necessary to support a waiver of the AIS requirements, as may be requested by the Purchaser.

Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment

The Contractor acknowledges to and for the benefit of the City of Mt. Clemens (“Owner”) and the Michigan Department of Environment, Great Lakes, and Energy (the “Funding Authority”) that it understands:

This term and condition implements 2 CFR 200.216 and is effective for obligations and expenditures of the U.S. Environmental Protection Agency (or EPA)’s financial assistance funding on or after 8/13/2020.

As required by 2 CFR 200.216, EPA recipients and subrecipients, including borrowers under EPA funded revolving loan fund programs, are prohibited from obligating or expending loan or grant funds to procure or obtain; extend or renew a contract to procure or obtain; or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that use covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115-232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities). Recipients, subrecipients, and borrowers also may not use EPA funds to purchase:

- a. For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).
- b. Telecommunications or video surveillance services provided by such entities or using such equipment.
- c. Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

Consistent with 2 CFR 200.471, costs incurred for telecommunications and video surveillance services or equipment such as phones, internet, video surveillance, and cloud servers are allowable except for the following circumstances:

- a. Obligating or expending EPA funds for covered telecommunications and video surveillance services or equipment or services as described in 2 CFR 200.216 to:
 - (1) Procure or obtain, extend or renew a contract to procure or obtain;
 - (2) Enter into a contract (or extend or renew a contract) to procure; or
 - (3) Obtain the equipment, services, or systems. Certain prohibited equipment, systems, or services, including equipment, systems, or services produced or provided by entities identified in section 889, are recorded in the System for Award Management exclusion list.

Davis-Bacon and Related Acts/Prevailing Federal Wages

P.L. 111-88 requires compliance with the Davis Bacon Act and adherence to the current U.S. Department of Labor Wage Decision. Attention is called to the fact that not less than the minimum salaries and wages as set forth in the Contract Documents (see Wage Decision included herein) must be paid on this project. The Wage Decision, including modifications, must be posted by the Contractor on the job site. The “Contracting Agency” or “Contracting Officer” for Davis-Bacon Wage Decision posters on jobsites is the loan applicant/bond issuer. A copy of the Labor Standards Provisions for Federally Assisted Projects is included and is hereby a part of this contract.

"General Decision Number: MI20240091 01/19/2024

Superseded General Decision Number: MI20230091

State: Michigan

Construction Type: Building

County: Macomb County in Michigan.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	<ul style="list-style-type: none">. Executive Order 14026 generally applies to the contract.. The contractor must pay all covered workers at least \$17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	<ul style="list-style-type: none">. Executive Order 13658 generally applies to the contract.. The contractor must pay all covered workers at least \$12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number	Publication Date
0	01/05/2024
1	01/19/2024

ASBE0025-002 06/01/2022

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 36.63	32.91

BOIL0169-001 06/01/2023

	Rates	Fringes
BOILERMAKER.....	\$ 39.95	35.38

BRMI0001-001 06/01/2022

	Rates	Fringes
BRICKLAYER.....	\$ 38.87	25.18
TILE FINISHER.....	\$ 30.75	22.67
TILE SETTER.....	\$ 37.88	22.67

CARP0687-003 06/01/2023

	Rates	Fringes
CARPENTER (Including Acoustical Ceiling Installation, Drywall Hanging, Form Work, Metal Stud Installation & Scaffold Building).....	\$ 40.98	30.22

* CARP1045-001 06/01/2023

	Rates	Fringes
CARPENTER (Floor Layer - Carpet, Resilient, & Vinyl Flooring).....	\$ 34.00	27.53

* CARP1102-002 06/01/2023

	Rates	Fringes
MILLWRIGHT.....	\$ 35.47	39.24

ELEC0058-001 07/21/2022

	Rates	Fringes
ELECTRICIAN (Low Voltage Wiring and Installation of Alarms) Installer.....	\$ 30.12	14.57
Technician.....	\$ 39.33	14.95
ELECTRICIAN.....	\$ 48.52	26.11

ELEV0036-002 01/01/2023

	Rates	Fringes
ELEVATOR MECHANIC.....	\$ 59.82	37.335+a+b

FOOTNOTES:

A. PAID HOLIDAYS: New Years Day; Memorial Day; Independence Day; Labor Day; Veterans' Day; Thanksgiving Day; the Friday after Thanksgiving Day; and Christmas Day.

B. Employer contributes 8% basic hourly rate for 5 years or more of service of 6% basic hourly rate for 6 months to 5 years of service as vacation pay credit.

 ENGI0324-017 06/01/2023

	Rates	Fringes
OPERATOR: Power Equipment		
GROUP 1.....	\$ 47.49	25.35
GROUP 2.....	\$ 46.29	25.35
GROUP 3.....	\$ 44.79	25.35
GROUP 4.....	\$ 44.49	25.35
GROUP 5.....	\$ 43.67	25.35
GROUP 6.....	\$ 42.81	25.35
GROUP 7.....	\$ 41.84	25.35
GROUP 8.....	\$ 40.13	25.35
GROUP 9.....	\$ 31.79	25.35

FOOTNOTES:

Tower cranes: to be paid the crane operator rate determined by the combined length of the mast and the boom. If the worker must climb 50 ft. or more to the work station, \$.25 per hour additional.

Derrick and cranes where the operator must climb 50 ft. or more to the work station, \$.25 per hour additional to the applicable crane operator rate.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

GROUP 1: Crane with boom and jib or leads 400' or longer

GROUP 2: Crane with boom and jib or leads 300' or longer

GROUP 3: Crane with boom and jib or leads 220' or longer

GROUP 4: Crane with boom and jib or leads 140' or longer

GROUP 5: Crane with boom and jib or leads 120' or longer

GROUP 6: Regular crane operator, and concrete pump with boom operator

GROUP 7: Backhoe/Excavator/Trackhoe, bobcat/skid Loader, broom/sweeper, bulldozer, grader/blade, highlift, hoist, loader, roller, scraper, tractor & trencher

GROUP 8: Forklift & extend-a-boom forklift

GROUP 9: Oiler

 IRON0025-019 06/01/2022

	Rates	Fringes
IRONWORKER		
REINFORCING.....	\$ 31.43	34.77

STRUCTURAL.....\$ 34.85 40.42

IRON0025-022 06/01/2022

Rates Fringes

IRONWORKER STRUCTURAL (Metal Building Erection Only).....\$ 25.81 26.43

LAB00259-002 08/01/2023

Rates Fringes

LABORER: Asbestos Abatement (Removal from Floors, Walls & Ceilings).....\$ 34.53 15.47

LAB00334-005 06/01/2023

Rates Fringes

LABORER: Landscape & Irrigation
GROUP 1.....\$ 25.97 8.60
GROUP 2.....\$ 23.75 8.60

CLASSIFICATIONS

GROUP 1: Landscape specialist, including air, gas and diesel equipment operator, lawn sprinkler installer, skidsteer (or equivalent)

GROUP 2: Landscape laborer: small power tool operator, material mover, truck driver and lawn sprinkler installer tender

LAB01191-002 06/01/2023

Rates Fringes

LABORER
Common or General; Grade Checker; Mason Tender - Brick/Cement/Concrete; Pipelayer; Sandblaster.....\$ 32.95 16.95

PAIN0022-003 06/01/2022

Rates Fringes

PAINTER: Brush and Roller.....\$ 32.85 20.41
PAINTER: Drywall Finishing/Taping.....\$ 32.85 20.41
PAINTER: Spray.....\$ 26.86 17.66

PAIN0357-002 06/01/2023

Rates Fringes

GLAZIER.....\$ 38.66 20.98

PAID HOLIDAYS: New Year's Day, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day; provided that the employee has worked the last full regular

scheduled work day prior to the holiday, and the first full regular scheduled work day following the holiday, provided the employee is physically able to work.

PLAS0067-001 04/01/2014		
	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 30.63	14.07

PLAS0067-004 04/01/2014		
	Rates	Fringes
PLASTERER.....	\$ 30.63	14.07

PLUM0098-001 06/01/2023		
	Rates	Fringes
PLUMBER, Excludes HVAC Pipe and Unit Installation.....	\$ 35.79	28.28

PLUM0636-003 06/05/2023		
	Rates	Fringes
PIPEFITTER, Includes HVAC Pipe and Unit Installation.....	\$ 44.70	35.37

ROOF0149-001 07/01/2021		
	Rates	Fringes
ROOFER.....	\$ 38.16	25.91

SFMI0704-001 08/01/2023		
	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	\$ 49.16	32.86

SHEE0080-004 06/01/2022		
	Rates	Fringes
SHEET METAL WORKER (Including HVAC Duct Installation; Excluding HVAC System Installation).....	\$ 47.64	26.15

TEAM0247-002 06/01/2023		
	Rates	Fringes
TRUCK DRIVER		
GROUP 1		
Dump; Flatbed; Pickup.....	\$ 29.82	0.70+a+b
GROUP 2		
Semi.....	\$ 29.97	0.70+a+b
GROUP 3		
Lowboy.....	\$ 30.07	0.70+a+b

PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. If any of the above holidays fall on a Sunday, the following Monday shall be considered the holiday and, if work is performed, the rate shall be double time.

FOOTNOTE:

a. \$456.70 per week, plus \$67.10 per day.

* SUMI2011-016 02/01/2011

	Rates	Fringes
INSTALLER - OVERHEAD DOOR.....	\$ 27.98	0.00
IRONWORKER, ORNAMENTAL.....	\$ 18.48	7.93
TRUCK DRIVER: Tractor Haul Truck.....	\$ 13.57 **	1.18

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$17.20) or 13658 (\$12.90). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classification

and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

Labor Standards Provisions for Federally Assisted Projects - 29 CFR Part 5

§5.5 Contract provisions and related matters.

(a) The Agency head shall cause or require the contracting officer to insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in Sec. 5.1, the following clauses (or any modifications thereof to meet the particular needs of the agency, *Provided*, That such modifications are first approved by the Department of Labor):

(1) *Minimum wages.* (i) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in Sec. 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination, and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

- (2) The classification is utilized in the area by the construction industry; and
- (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- (B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
- (C) In the event the contractor, the laborers, or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
- (D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
- (iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
- (iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside, in a separate account, assets for the meeting of obligations under the plan or program.
- (2) *Withholding.* The **(write in name of Federal Agency or the loan or grant recipient)** shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the

work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

- (3) *Payrolls and basic records.* (i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made, and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.
- (ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency). The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead, the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at dol.gov/agencies/whd/government-contracts/construction/forms or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency), the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, sponsor, or owner).

- (B) Each payroll submitted shall be accompanied by a "Statement of Compliance", signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:
- (1) That the payroll for the payroll period contains the information required to be provided under Sec. 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under Sec. 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete.
 - (2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;
 - (3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
- (C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.
- (D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.
- (iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the Michigan Department of Environment, Great Lakes, and Energy or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as maybe necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.
- (4) *Apprentices and trainees-* (i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the

applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the jobsite in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

- (ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.
- (iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.
- (5) *Compliance with Copeland Act requirements.* The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

- (6) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.
- (7) *Contract termination: debarment.* A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.
- (8) *Compliance with Davis-Bacon and Related Act requirements.* All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.
- (9) *Disputes concerning labor standards.* Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.
- (10) *Certification of eligibility.* (i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C.1001.
- (b) *Contract Work Hours and Safety Standards Act.* The Agency Head shall cause or require the contracting officer to insert the following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Sec. 5.5(a) or 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.
- (1) *Overtime requirements.* No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.
- (2) *Violation; liability for unpaid wages; liquidated damages.* In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible there for shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be

liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

- (3) Withholding for unpaid wages and liquidated damages. The ***(write in the name of the Federal agency or the loan or grant recipient)*** shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.
- (4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.
- (c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in Sec.5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Michigan Department of Environment, Great Lakes, and Energy and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

Disadvantaged Business Enterprises (DBE) Requirements

Prime contractors bidding on this project must follow, document, and maintain documentation of their Good Faith Efforts (GFE), as listed below, to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach. Bidders must make the following Good Faith Efforts for any work that will be subcontracted.

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. Place DBEs on solicitation lists and solicit DBEs whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs. Arrange timeframes for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date. The DBEs should be given a minimum of 5 days to respond to the posting.
3. Consider in the contracting process whether firms competing for large contracts can be subcontracted with DBEs. Divide total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
4. Encourage contracting with a consortium of DBEs when a contract is too large for one DBE firm to handle individually.
5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.

Subsequent to compliance with the Good Faith Efforts, the following conditions also apply under the DBE requirements. Completed Good Faith Efforts Worksheets, along with the required supporting documentation outlined in the instructions, must be submitted with your bid proposal. EPA form 6100-2 must also be provided at the pre-bid meeting. A copy of this form is available on the Forms and Guidance page of the EGLE Water Infrastructure Financing Section website.

1. The prime contractor must pay its subcontractor for work that has been satisfactorily completed no more than 30 days from the prime contractor's receipt of payment from the owner.
2. The prime contractor must notify the owner in writing prior to the termination of any DBE subcontractor for convenience by the prime contractor and employ the Good Faith Efforts if soliciting a replacement contractor.
3. If a DBE contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the Good Faith Efforts if soliciting a replacement contractor.
4. The prime contractor must employ the Good Faith Efforts.

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Good Faith Efforts Worksheet

Bidder: _____

Subcontract Area of Work (one per worksheet): _____

Outreach Goal: Solicit a minimum of three (3) DBEs via email/letter/fax. It is recommended that various sources be used to locate the minimum number of DBEs. The Michigan Department of Transportation (MDOT) website and www.sam.gov registries may be two resources used to find a minimum of three DBEs.

List the DBEs contacted for the above area of work and complete the following information for each.

Company Name	Contact Method	Date Contacted	Price Quote Received	Accepted or Rejected	If rejected, explain why

Explanation for Not Achieving a Minimum of Three Contacts; you may include a printout of the MDOT and www.sam.gov search results (attach extra sheets if necessary):

MITA DBE Posting Date (if applicable): _____
(Attach a copy of the DBE advertisement)

Other Efforts (attach extra sheets if necessary):

Please include the completed worksheet and supporting documentation with the bid proposal.

Instructions to Bidders for the Completion of the Good Faith Efforts Worksheet

1. Separate worksheets must be provided for each area of work to be subcontracted out. This includes both major and minor subcontracts.
2. A minimum of three (3) DBEs must be contacted by a verifiable means of communication such as email, letter, or fax for each area of work to be subcontracted out. Copies of the solicitation letters/emails and fax confirmation sheets must be provided with the worksheet.
3. If less than three (3) DBEs exist statewide for the area of work, then provide documentation that other DBE resources were consulted. This may include the MDOT and www.sam.gov registries and an advertisement in a publication. A printout of the website searched (conducted prior to the end of the bid period) must be submitted.
4. Posting solicitations for quotes/proposals from DBEs on the MITA website (www.mitadbe.com) is highly recommended to facilitate participation in the competitive process whenever possible. The solicitation needs to identify the project and the areas of work to be subcontracted out. A copy of the MITA DBE advertisement must be submitted with the Good Faith Efforts worksheet, if used, or a printout of the resulting quotes posted to the MITA website can be submitted with this form as supporting documentation.
5. If the area of work is so specialized that no DBEs exist, then an explanation is required to support that conclusion, including the documentation required in number 3 above.
6. The date of the DBE contact must be identified, as it is important to document that the DBE solicitation was made during the bid period and that sufficient time was given for the DBE to return a quote.
7. Each DBE firm's price quote must be identified if one was received, or N/A entered on the worksheet if a quote was not received. Copies of all quotes must be submitted with the worksheet.
8. If a quote was received, indicate if it was accepted or rejected. Justification for not accepting a quote and not using the DBE subcontractor must be provided.
9. Under Other Efforts, please indicate additional steps you have taken to obtain DBE contractors and provide the appropriate supporting documentation such as:
 - Follow-up emails, faxes, or letters.
 - Copies of announcements/postings in newspapers, trade publications, or minority media that target DBE firms.

Disadvantaged Business Enterprise (DBE) and Good Faith Efforts (GFE) Requirements Frequently Asked Questions Regarding Contractor Compliance

Q: What is the Good Faith Efforts Worksheet and how is it completed?

A: The worksheet captures efforts by the prime contractor to solicit DBEs for each area of work type that will be subcontracted out. A separate GFE Worksheet must be provided by the prime contractor for each area of work type to be subcontracted out. There are specific instructions that accompany the worksheet that prescribe minimum efforts which bidders must make in order to be in compliance with the DBE requirements.

Q: Can non-certified DBEs be used?

A: While non-certified DBEs can be used, only DBEs, MBEs, and WBEs that are certified by EPA, SBA, or MDOT (or by tribal, state and local governments, as long as their standards for certification meet or exceed the standards in EPA policy) can be counted toward the fair share goal. Proof of certification by one of these recognized and approved agencies should be sought from each DBE.

Q: How does a DBE get certified?

A: Applications to be certified by MDOT can be found at

mdotjboss.state.mi.us/MUCPWeb/eligibilityRequirements.htm

To register with the U.S. Small Business Association visit sba.gov/federal-contracting/contracting-assistance-programs/small-disadvantaged-business

To be certified by EPA, a DBE must first have sought certification through SBA, MDOT, or a tribal, state, or local organization and be unsuccessful in that attempt.

Q: If a bidder follows the MDOT DBE requirements, will the bidder comply with the SRF DBE requirements?

A: No. Federally funded highway projects utilize DBE goals, which require a certain percentage of work be performed by DBE subcontractors. For SRF projects, there is no financial goal. However, there is a solicitation effort goal. Bidders must use Good Faith Efforts for each and every area of work to be subcontracted out to obtain DBEs. The bidders are not required to use DBEs if the quotes are higher than non-DBE subcontractors. There is no required DBE participation percentage contract goal for the SRF. However, if the SRF project is part of a joint project with MDOT, the project can be excluded from SRF DBE requirements (i.e., the Good Faith Efforts Worksheet is not required) as it would be difficult to comply with both programs' requirements.

Q: Should the Good Faith Efforts Worksheet and supporting documentation be submitted with bid proposals?

A: Yes. This is a requirement to document that the contractor has complied with the DBE requirements and GFE. These compliance efforts must be done during the bidding phase and not after-the-fact. It is highly recommended that the need for these efforts and the submittal of the forms with the bid proposals be emphasized at the pre-bid meeting. Failure to show that the Good Faith Efforts were complied with during the bidding process can lead to a prime contractor being found non-responsive.

Q: What kinds of documentation should a contractor provide to document solicitation efforts?

A: Documentation can include fax confirmation sheets, copies of solicitation letters/emails, printouts of online solicitations, printouts of online search results, affidavits of publication in newspapers, etc.

- Q:** What if no forms are turned in with the bid proposal or forms are blank or incomplete? Should this be cause to determine that the bidder is non-responsive?
- A:** While the Good Faith Efforts Worksheet is important, it is more critical to confirm that the contractor complied with the DBE requirements prior to bid opening. The owner should contact the bidder as soon as deficiencies are noted for documentation of efforts taken to comply with the DBE requirements. Immediate submittal of the completed forms will be acceptable provided the Good Faith Efforts were made and it is just a matter of transferring information to the forms.
- Q:** How much time will compliance with GFE require in terms of structuring an adequate bidding period?
- A:** Due to the extent of the efforts required, a minimum of 30 calendar days is recommended between bid posting and bid opening to ensure adequate time for contractors to locate certified DBEs and solicit quotes.
- Q:** How does a contractor locate certified DBEs?
- A:** MDOT has a directory of all Michigan certified entities located at mdotjboss.state.mi.us/MUCPWeb/. Additionally, the federal System for Award Management (SAM) is another place to search and can be found at sam.gov. SAM contains information from the former Central Contractor Registration (CCR) database.
- Q:** If the bidder does not intend to subcontract any work, what forms, if any, must be provided with the bid proposal?
- A:** The bidder should complete the Good Faith Efforts Worksheet with a notation that no subcontracting will be done. However, if the bidder is awarded the contract and then decides to subcontract work at any point, then the Good Faith Efforts must be made to solicit DBEs.
- Q:** If the prime contractor is a DBE, does he have to solicit DBE subcontractors?
- A:** Yes, the DBE requirements still apply if the prime intends to subcontract work out. GFE must be used to solicit DBEs.
- Q:** If the area of work is one where there are less than three DBE contractors, how is the contractor to document this?
- A:** Copies of printouts from MDOT and SAM showing no DBEs and advertisements soliciting quotes for all subcontract areas, including the questionable areas, will be adequate if the dates on the printouts are prior to the bid or proposal closing date.

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Certification Regarding Debarment, Suspension, and Other Responsibility Matters

The prime contractor must provide a completed *Certification Regarding Debarment, Suspension, and Other Responsibility Matters Form* with its bid or proposal package to the owner.

The prospective participant certifies, to the best of its knowledge and belief, that it and its principals:

- (1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in transactions under federal nonprocurement programs by any federal department or agency;
- (2) Have not, within the three-year period preceding the proposal, had one or more public transactions (federal, state, or local) terminated for cause or default; and
- (3) Are not presently indicted or otherwise criminally or civilly charged by a government entity (federal, state, or local) and have not, within the three-year period preceding the proposal, been convicted of or had a civil judgment rendered against it:
 - (a) For the commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public transaction (federal, state, or local) or a procurement contract under such a public transaction;
 - (b) For the violation of federal or state antitrust statutes, including those proscribing price fixing between competitors, the allocation of customers between competitors, or bid rigging; or
 - (c) For the commission of embezzlement, theft, forgery, bribery, falsification, or destruction of records, making false statements, or receiving stolen property.

I understand that a false statement on this certification may be grounds for the rejection of this proposal or the termination of the award. In addition, under 18 U.S.C. §1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to five years, or both.

Name and Title of Authorized Representative

Name of Participant Agency or Firm

Signature of Authorized Representative

Date

I am unable to certify to the above statement. Attached is my explanation.

IRAN ECONOMIC SANCTIONS ACT CERTIFICATION

I am the _____ of _____, or I am
(title) (bidder)

bidding in my individual capacity ("Bidder"), with authority to submit a binding bid for the provision of services related to construction improvements for City of Mount Clemens. I have personal knowledge of the matters described in this Certification, and I am familiar with the Iran Economic Sanctions Act, MCL 129.311, et seq. ("Act"). I am fully aware that the City will rely on my representations in evaluating bids.

I certify that Bidder is not an Iran-linked business, as that term is defined in the Act. I understand that submission of a false certification may result in contract termination, ineligibility to bid for three (3) years, and a civil penalty of \$250,000 or twice the bid amount, whichever is greater, plus related investigation and legal costs.

(signature)

(printed)

(date)

AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between City of Mount Clemens (“Owner”) and _____ (“Contractor”).

Terms used in this Agreement have the meanings stated in the General Conditions and other Contract Documents.

Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

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

- A. The Work primarily consists of improvements to the WWTP including replacement of the waste return activated sludge pumping, installation of new solids handling equipment, and electrical and instrumentation improvements. The solids handling screw presses, conveyors, polymer blending units and control panels have been pre-purchased and will be installed by Contractor.

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows:

MOUNT CLEMENS, MICHIGAN
WASTEWATER TREATMENT PLANT
BIOSOLIDS IMPROVEMENTS
BID NO. 022405
Contract 200-12747-23001-S-4
SRF PROJECT NO. 5969-01

ARTICLE 3—ENGINEER

3.01 The Owner has retained Tetra Tech, Inc., whose address is 1136 Oak Valley, Ann Arbor, MI 48176 (“Engineer”) to act as Owner’s Engineer, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract Documents.

3.02 The Project has been designed by Engineer.

3.03 Engineer shall work closely and cooperatively with the Owner’s representative, who the Owner has designated to be the City Manager, Greg Shipman. The Owner’s representative is authorized to act on behalf of the Owner with respect to the Project, subject to applicable laws and

parameters of authority expressly established by the Owner's City Council. Engineer shall routinely and accurately inform the Owner's representative on matters related to the Project.

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 Not Used

4.03 *Contract Times: Dates*

A. The Work will be substantially complete by December 31, 2024 and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions by January 30, 2025.

4.04 *Not Used*

4.05 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner One Thousand five hundred and 00/100 Dollars (\$1,500.00) for each calendar day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.
 2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner One Thousand five hundred and 00/100 Dollars (\$1,500.00) for each calendar day that expires after such time until the Work is completed and ready for final payment.
- B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, that are solely attributable to such delay, except for special damages specified in this Agreement. The Contractor acknowledges and agrees that the foregoing sentence does not preclude its responsibility for damages that are not solely attributable to delay.

4.06 *Special Damages*

A. Contractor shall reimburse Owner (1) for any fines or penalties, including but not limited to revocation of grant award or funding, imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and (2) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection,

and administrative services needed after the time specified in Paragraph 4.05 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.

- B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.03 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.
- C. The special damages imposed in this paragraph are supplemental to the liquidated damages for delayed completion established in this Agreement at Paragraph 4.05.

ARTICLE 5—CONTRACT PRICE

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

- A. For all Work other than Unit Price Work, a lump sum of _____ Dollars (\$_____).
- B. All specific cash allowances are included in the price set forth in Paragraph 5.01.A, above, in accordance with Paragraph 13.02 of the General Conditions. Without limiting the breadth of the foregoing, all of the following are included within the above price:
 - 1. Any unused portion of an allowance shall be returned to the Owner.

C. All specific OWNER selected alternates listed below are included in the price(s) set forth above and have been computed in accordance with the General Conditions. The following items and quantities are deemed **included** within the price set forth in Paragraph 5.01.A, above.

- 1. Alternate No. 1 (deduct) \$ _____
- 2. Alternate No. 2 (deduct) \$ _____
- 3. Alternate No. 3 (deduct) \$ _____

D Lump Sum Price Adjustments have been established for this Contract. Any discrepancy in quantities actually used will result in a corresponding increase or decrease in the lump sum price as set forth below:

Item and Locations in Specifications	Unit for Adjustment	Included in Base Bid	Adjustment Price per Unit
Concrete Surface Repair (03930) Less than 2-inch Depth	Square Foot	200 SF	
Concrete Surface Repair (03930) Greater than 2-inch Depth	Square Foot	100 SF	
Concrete Crack Epoxy Resin Injection (03930)	Lineal Foot	100 LF	

E. Estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer.

F. All specific Owner-selected alternates are included within the price set forth in Paragraph 5.01.A, above.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

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

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on the basis of Contractor’s Applications for Payment during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such

Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.
 - a. Ninety percent (90%) of the value of the Work completed (with the balance being retainage).
 - 1) If 50 percent or more of the Work has been completed, as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage. If the character and progress of the Work have not been satisfactory to the Owner and Engineer, the Owner may continue to withhold retainage of up to ten percent (10%).
2. Retained funds shall be deposited in an interest bearing account in a regulated financial institution in the State of Michigan in accordance with MCL 125.1561, et seq.
- C. The Owner may request dispute resolution by Engineer for reasons set forth in MCL 125.1564(3), which shall impact the Owner's obligation to return retainage and interest as set forth in MCL 125.1564(7) and (8).
- D. A copy of MCL 125.1561, et seq., is included in the Bidding Documents.

6.03 *Final Payment*

- A. Upon final completion and acceptance of the Work, and subject to Paragraph 6.02.C, above, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

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

6.05 *Interest*

- A. All amounts not paid when due will bear interest at the rate of five percent (5%) per annum. (See MCL 438.31).

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

- A. The Contract consists of the Contract Documents, which include the following:
 1. This Agreement, which includes any Addenda that may be issued, change orders, or amendments to this Agreement.

2. Drawings consisting of _____ sheets
 3. Specifications
 4. Bonds:
 - a. Performance bond (together with power of attorney).
 - b. Payment bond (together with power of attorney).
 5. Contractor's Bid Response and other submissions.
- B. There are no Contract Documents other than those listed above in this Article 7.
- C. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.
- D. In the event of any inconsistency or ambiguity within, between, or among any Contract Document(s) as set forth in Article 7, the more restrictive requirement will apply.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 Contractor's Representations

- A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:
1. Contractor has examined and carefully studied the Contract Documents, including Addenda, and all other related information, data, and requirements in the Bidding Documents.
 2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
 3. Contractor is familiar with and agrees to comply with all Laws and Regulations that may affect cost, progress, and performance of the Work.
 4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Contract Documents, including with respect to the Technical Data in such reports and drawings.
 5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Contract Documents, including with respect to Technical Data in such reports and drawings.
 6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Contract Documents or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and

procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.

7. Contractor has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of 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, if any, expressly required by the Contract Documents to be employed by Contractor, and safety precautions and programs incident thereto.
8. Based on the information and observations referred to in this Article 8, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
9. 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.
10. All claims and disputes arising from related Work at Site by other contractors shall be settled in accordance with the Contract Documents.
11. Contractor has correlated the information known to Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
12. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
13. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
14. Contractor acknowledges that it shall not discriminate against any employee or applicant for employment with respect to hire, tenure, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of race, color, religion, national origin, age, sex, height, weight, marital status, or a disability that can be reasonable accommodated. Contractor must include this covenant in any agreement with any subcontractor employed in the performance of this Contract. A breach of this covenant shall be regarded as a material breach of the Contract.
15. Owner will require the use of prevailing wage rates on this Project. Section 00450 – Prevailing Wage Rates, General Decision Number MI20230091, dated 12/15/2023
16. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

- A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:
1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;
 2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
 3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and
 4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions and Contract Requirements*

- A. Owner and Contractor acknowledge that a modified version of the General Conditions applies to this Project and is hereby incorporated by reference as if fully restated. Contractor acknowledges having received and reviewed the modified General Conditions and agrees to be bound by the terms therein.
- B. Contractor acknowledges and agrees that all the following apply to this Contract and are incorporated herein by reference as if fully restated:
- Prevailing Wage Contract Language (see Specifications Section 00450)
 - Prevailing Wage Determination (see Specifications Section 00450)
 - Debarment/Suspension Certification (see Specifications Section 00450)
 - Iran Economic Sanctions Act Certification
 - Notice to Proceed (see Specifications Section 00550)
 - MCL 125.1561, et seq. (see Specifications 00615)

ARTICLE 9 – MISCELLANEOUS

9.01 Terms.

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

9.02 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.

9.03 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.

9.04 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.

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

This Agreement will be effective on **[indicate date on which Contract becomes effective]** (which is the Effective Date of the Contract).

Owner:

(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone: _____

Email: _____

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

Contractor:

(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

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

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone: _____

Email: _____

License No.: _____
(where applicable)

State: _____

NOTICE OF AWARD

Dated _____

TO: _____
(BIDDER)

ADDRESS: _____

Contract: _____
(Insert name of Contract as it appears in the Bidding Documents)

Contract No. _____

You are notified that your Bid dated _____, 20__ for the above Contract has been considered responsive and responsible by OWNER. You are the apparent Successful Bidder and have been awarded a Contract for _____
(Project Description)

For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated in the Unit Price Table located in Section 00400, Bid Form:

The total for all unit prices establishes your Contract Price as _____ dollars (\$ _____).

The Contract Price of your lump sum Contract is _____ dollars (\$ _____).

___ Copies of each of the proposed Contract Documents (except Drawings) will be delivered within ___ days, under separate cover. ___ sets of the Drawings will be delivered separately or otherwise made available to you immediately.

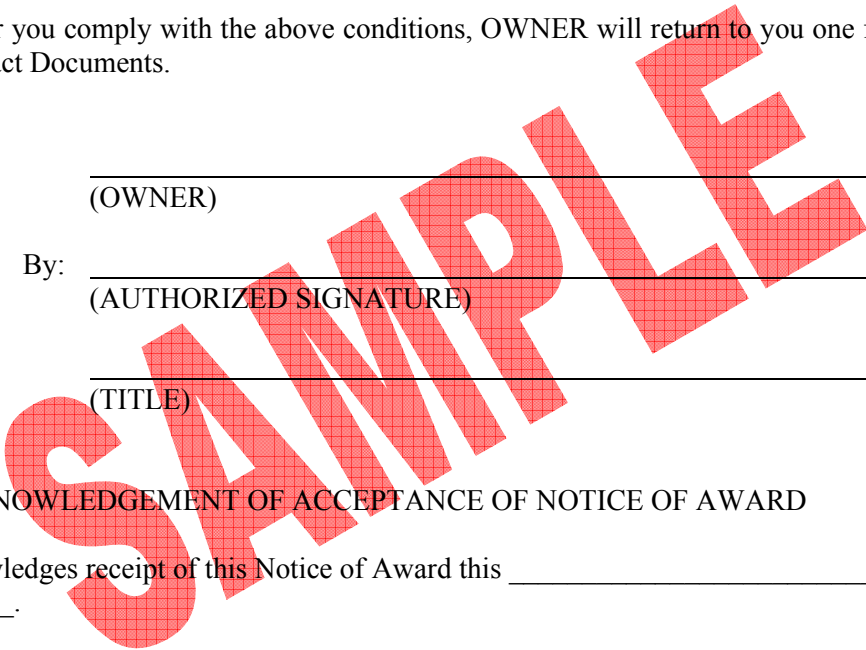
You must comply with the following conditions precedent within ten days of the date you receive this Notice of Award.

1. Deliver to the ENGINEER ___ fully executed counterparts of the Contract Documents. (Each of the Contract Documents must bear your signature on Page ___ of Section 00500, Agreement.)
2. Deliver with the executed Contract Documents the Contract security (Bonds) and ten copies of all insurance certificates as specified in the Instructions to Bidders (Article 20), and General Conditions (Article 6 – Bonds and Insurance).

- 3. Deliver to OWNER with copy to ENGINEER an acknowledged copy of this Notice of Award.
- 4. (List other conditions precedent).

Failure to comply with these conditions within the time specified will entitle OWNER to consider your Bid in default, to annul this Notice of Award and to declare your Bid security forfeited. OWNER will be entitled to such other rights as may be granted by law.

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



(OWNER)

By: _____
(AUTHORIZED SIGNATURE)

(TITLE)

ACKNOWLEDGEMENT OF ACCEPTANCE OF NOTICE OF AWARD

CONTRACTOR acknowledges receipt of this Notice of Award this _____ day of _____, 20__.

(CONTRACTOR)

By: _____
(AUTHORIZED SIGNATURE)

(TITLE)

cc: OWNER w/1
CONTRACTOR w/1
Tt (ENGINEER) w/1
File w/1

NOTICE TO PROCEED

Dated _____

TO: _____
(CONTRACTOR)

ADDRESS: _____

Contract: _____
(Insert name of Contract as it appears in the Contract Documents)

Contract No. 200-12747-23001-S-4 _____

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

Deliver to OWNER with copy to ENGINEER an acknowledged copy of this Notice to Proceed.

City of Mount Clemens _____
(OWNER)

By: _____
(AUTHORIZED SIGNATURE)

City Manager _____
(TITLE)

ACKNOWLEDGEMENT OF ACCEPTANCE OF NOTICE TO PROCEED

CONTRACTOR acknowledges receipt of this Notice to Proceed this _____ day
of _____, 20__.

(CONTRACTOR)

By: _____
(AUTHORIZED SIGNATURE)

(TITLE)

cc: OWNER w/1
CONTRACTOR w/1
Tt (ENGINEER) w/1
File w/1

SECTION 00611 - CONSENT OF SURETY

Attach Consent of Surety to this Page.

PERFORMANCE BOND

CONTRACTOR (name and address):

SURETY (name and address of principal place of business):

OWNER (name and address):

CONSTRUCTION CONTRACT

Effective Date of the Agreement:

Amount:

Description (name and location):

BOND

Bond Number:

Date (not earlier than the Effective Date of the Agreement of the Construction Contract):

Amount:

Modifications to this Bond Form: None See Paragraph 16

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

CONTRACTOR AS PRINCIPAL

SURETY

(seal)

Contractor's Name and Corporate Seal

(seal)

Surety's Name and Corporate Seal

By: _____
Signature

By: _____
Signature (attach power of attorney)

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

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

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall 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 shall 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 shall 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 shall 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 shall 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 shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall 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 shall not be reduced or set off on account of any such unrelated obligations. No right of action shall 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 may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within the period specified by Michigan law for contract actions. If the provisions of this paragraph are void or prohibited by law, the maximum periods of limitations available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the Owner, or the Contractor shall 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 shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall 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 waived as provided in the Construction Contract, 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 shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

16. Modifications to this Bond are as follows:

16.1 Contractual limitations period has been removed from Paragraph 11;

16.2 Contractor Default includes all Contractor non-performance or failures to comply with a material term of the Construction Contract unless waived by Owner in accordance with the provisions of the Construction Contract;

16.3 The Surety, Owner, and Contractor acknowledge and agree that this bond is furnished to comply with Public Act 213 of 1963 and, accordingly, is a statutory bond and shall be interpreted in accordance with Michigan law regarding statutory bonds

PAYMENT BOND

CONTRACTOR (name and address):

SURETY (name and address of principal place of business):

OWNER (name and address):

CONSTRUCTION CONTRACT

Effective Date of the Agreement:

Amount:

Description (name and location):

BOND

Bond Number:

Date (not earlier than the Effective Date of the Agreement of the Construction Contract):

Amount:

Modifications to this Bond Form: None See Paragraph 18

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

CONTRACTOR AS PRINCIPAL

SURETY

_____ (seal)

Contractor's Name and Corporate Seal

_____ (seal)

Surety's Name and Corporate Seal

By: _____

Signature

By: _____

Signature (attach power of attorney)

Print Name

Print Name

Title

Title

Attest: _____

Signature

Attest: _____

Signature

Title

Title

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

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall 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 shall 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 shall 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 shall 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 shall 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 shall be used for the performance of the Construction Contract. 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 satisfy obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion or correction 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 shall 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 shall be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall 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 shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall 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:
 1. The name of the Claimant;
 2. The name of the person for whom the labor was done, or materials or equipment furnished;
 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;
 4. A brief description of the labor, materials, or equipment furnished;
 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;
 - 16.2 **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 shall be 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 shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.
18. Modifications to this Bond are as follows:

18.1 Paragraph 9 has been modified to require amounts owed to the Contractor by Owner under the Construction Contract to only be used for the performance of the Construction Contract and to allow the Owner priority to use funds earned by the Contractor under the Construction Contract for the completion and correction of the Work.

18.2 The Surety, Owner, and Contractor acknowledge and agree that this bond is furnished to comply with Public Act 213 of 1963 and, accordingly, is a statutory bond and shall be interpreted in accordance with Michigan law regarding statutory bonds, including but not limited to a statute of limitations period consistent with Michigan law and not as limited by Section 12 hereof.

CONSTRUCTION CONTRACTS WITH CERTAIN PUBLIC AGENCIES
Act 524 of 1980

AN ACT to provide for the terms of certain construction contracts with certain public agencies; to regulate the payment and retainage of payments on construction contracts with certain public agencies; and to provide for the resolution of certain disputes.

History: 1980, Act 524, Eff. Jan. 1, 1983.

The People of the State of Michigan enact:

125.1561 Definitions. [M.S.A. 5.2949(101)]

Sec. 1. As used in this act:

- (a) "Agent" means the person or persons agreed to or selected by the contractor and the public agency pursuant to section 4(2).
- (b) "Architect or professional engineer" means an architect or professional engineer licensed under Act No. 299 of the Public Acts of 1980, being sections 339.101 to 339.2601 of the Michigan Compiled Laws, and designated by a public agency in a construction contract to recommend progress payments.
- (c) "Construction contract" or "contract" means a written agreement between a contractor and a public agency for the construction, alteration, demolition, or repair of a facility, other than a contract having a dollar value of less than \$30,000.00 or a contract that provides for 3 or fewer payments.
- (d) "Contract documents" means the construction contract; instructions to bidders; proposal; conditions of the contract; performance bond; labor and material bond; drawings; specifications; all addenda issued before execution of the construction contract and all modifications issued subsequently.
- (e) "Contractor" means an individual, sole proprietorship, partnership, corporation, or joint venture, that is a party to a construction contract with a public agency.
- (f) "Facility" means a building, utility, road, street, boulevard, parkway, bridge, ditch, drain, levee, dike, sewer, park, playground, or other structure or work that is paid for with public funds or a special assessment.
- (g) "Progress payment" means a payment by a public agency to a contractor for work in place under the terms of a construction contract.
- (h) "Public agency" means this state, or a county, city, township, village, assessment district, or other political subdivision, corporation, commission, agency, or authority created by law. However, public agency does not include the state transportation department, a school district, junior or community college, the Michigan state housing development authority created in Act No. 346 of the Public Acts of 1966, as amended, being sections 125.1401 to 125.1496 of the Michigan Compiled Laws, and a municipal electric utility or agency. "Assessment district" means the real property within a distinct area upon which special assessments are levied or imposed for the construction, reconstruction, betterment, replacement, or repair of a facility to be paid for by funds derived from those special assessments imposed or levied on the benefited real property.
- (i) "Retainage" or "retained funds" means the amount withheld from a progress payment to a contractor pursuant to section 3.

History: 1980, Act 524, Eff. Jan. 1, 1983.

125.1562 Construction contract; designation of person to submit written requests for progress payments; designation of person to whom requests for progress payments to be submitted; manner and times of submissions; deferring the processing of progress payments; payment of requested progress payment; failure of public agency to make timely progress payment; interest. [M.S.A. 5.2949(102)]

Sec. 2. (1) The construction contract shall designate a person representing the contractor who will submit written requests for progress payments, and a person representing the public agency to whom request for progress payments are to be submitted. The written requests for progress payments shall be submitted to the designated person in a manner and at such times as provided in the construction contract.

(2) The processing of progress payments by the public agency may be deferred by the public agency until work having a prior sequence, as provided in the contract documents, is in place and is approved.

(3) Each progress payment requested, including reasonable interest if requested under subsection (4), shall be paid within 1 of the following time periods, whichever is later:

(a) Thirty days after the architect or professional engineer has certified to the public agency that work is in place in the portion of the facility covered by the applicable request for payment in accordance with the contract documents.

(b) Fifteen days after the public agency has received the funds with which to make the progress payment from a department or agency of the federal or state government, if any funds are to come from either of those sources.

(4) Upon failure of a public agency to make a timely progress payment pursuant to this section, the person designated to submit requests for progress payments may include reasonable interest on amounts past due in the next request for payment.

History: 1980, Act 524, Eff. Jan. 1, 1983.

125.1563 Retaining portion of each progress payment to assure proper performance of construction contract; retainage; limitations; exceeding pro rata share of public agency's matching requirement; commingling and deposit of retained funds; releasing to contractor retainage and interest earned on retainage; irrevocable letter of credit. [M.S.A. 5.2949(103)]

Sec. 3. (1) To assure proper performance of a construction contract by the contractor, a public agency may retain a portion of each progress payment otherwise due as provided in this section.

(2) The retainage shall be limited to the following:

(a) Not more than 10% of the dollar value of all work in place until work is 50% in place.

(b) After the work is 50% in place, additional retainage shall not be withheld unless the public agency determines that the contractor is not making satisfactory progress, or for other specific cause relating to the contractor's performance under the contract. If the public agency so determines, the public agency may retain not more than 10% of the dollar value of work more than 50% in place.

(3) The retained funds shall not exceed the pro rata share of the public agency's matching requirement under the construction contract and shall not be commingled with other funds of the public agency and shall be deposited in an interest bearing account in a regulated financial institution in this state wherein all such retained funds are kept by the public agency which shall account for both retainage and interest on each construction contract separately. A public agency is not required to deposit retained funds in an interest bearing account if the retained funds are to be provided under a state or federal grant and the retained funds have not been paid to the public agency.

(4) Except as provided in section 4(7) and (8), retainage and interest earned on retainage shall be released to a contractor together with the final progress payment.

(5) At any time after 94% of work under the contract is in place and at the request of the original contractor, the public agency shall release the retainage plus interest to the original contractor only if the original contractor provides to the public agency an irrevocable letter of credit in the amount of the retainage plus interest, issued by a bank authorized to do business in this state, containing terms mutually acceptable to the contractor and the public agency.

History: 1980, Act 524, Eff. Jan. 1, 1983.

125.1564 Construction contract; agreement to submit matters described in subsection (3) to decision of agent; designation of agent; dispute resolution process; use; agent to receive pertinent information and provide opportunity for informal meeting; decision of agent to be final and binding; vacation of decision by circuit court; dispute resolution resulting in decision; final progress payment to original contractor where public agency contracts with subsequent contractor. [M.S.A. 5.2949(104)]

Sec. 4. (1) The construction contract shall contain an agreement to submit those matters described in subsection (3) to the decision of an agent at the option of the public agency.

(2) If a dispute regarding a matter described in subsection (3) arises, the contractor and the public agency shall designate an agent who has background, training, and experience in the construction of facilities similar to that which is the subject of the contract, as follows:

(a) In an agreement reached within 10 days after a dispute arises.

(b) If an agreement cannot be reached within 10 days after a dispute arises, the public agency shall designate an agent who has background, training, and experience in the construction of facilities similar to that which is the subject of the contract and who is not an employee of the agency.

(3) The public agency may request dispute resolution by the agent regarding the following:

(a) At any time during the term of the contract, to determine whether there has been a delay for reasons that were within the control of the contractor, and the period of time that delay has been caused, continued, or aggravated by actions of the contractor.

(b) At any time after 94% of work under the contract is in place, whether there has been an unacceptable delay by the contractor in the performance of the remaining 6% of work under the contract. The agent shall consider the terms of the contract and the procedures normally followed in the industry and shall determine whether the delay was for failure to follow reasonable and prudent practices in the industry for completion of the project.

(4) This dispute resolution process shall be used only for the purpose of determining the rights of the parties to retained funds and interest earned on retained funds and is not intended to alter, abrogate, or limit any rights with respect to remedies that are available to enforce or compel performance of the terms of the contract by either party.

(5) The agent may request and shall receive all pertinent information from the parties and shall provide an opportunity for an informal meeting to receive comments, documents, and other relevant information in order to resolve the dispute. The agent shall determine the time, place, and procedure for the informal meeting. A written decision and reasons for the decision shall be given to the parties within 14 days after the meeting.

(6) The decision of the agent shall be final and binding upon all parties. Upon application of either party, the decision of the agent may be vacated by order of the circuit court only upon a finding by the court that the decision was procured by fraud, duress, or other illegal means.

(7) If the dispute resolution results in a decision:

(a) That there has been a delay as described in subsection (3)(a), all interest earned on retained funds during the period of delay shall become the property of the public agency.

(b) That there has been unacceptable delay as described in subsection (3)(b), the public agency may contract with a subsequent contractor to complete the remaining 6% of work under the contract, and interest earned on retained funds shall become the property of the public agency. A subsequent contractor under this subdivision shall be paid by the public agency from the following sources until each source is depleted, in the order listed below:

(i) The dollar value of the original contract, less the dollar value of funds already paid to the original contractor and the dollar value of work in place for which the original contractor has not received payment.

(ii) Retainage from the original contractor, or funds made available under a letter of credit provided under section 3(5).

(iii) Interest earned on retainage from the original contractor, or funds made available under a letter of credit provided under section 3(5).

(8) If the public agency contracts with a subsequent contractor as provided in subsection (7)(b), the final progress payment shall be payable to the original contractor within the time period specified in section 2(3). The amount of the final progress payment to the original contractor shall not include interest earned on retained funds. The public agency may deduct from the final progress payment all expenses of contracting with the subsequent contractor. This act shall not impair the right of the public agency to bring an action or to otherwise enforce a performance bond to complete work under a construction contract.

History: 1980, Act 524, Eff. Jan. 1, 1983.

125.1565 Construction contracts to which act applicable. [M.S.A. 5.2949(105)]

Sec. 5. (1) Except as provided in subsection (2), this act shall apply only to a construction contract entered into after the effective date of this act.

(2) For a construction contract entered into before the effective date of this act, the provisions of this act may be implemented by a public agency, through a contract amendment, upon the written request of the contractor, with such consideration as the public agency considers adequate.

History: 1980, Act 524, Eff. Jan. 1, 1983.

125.1566 Effective date. [M.S.A. 5.2949(106)]

Sec. 6. This act shall take effect January 1, 1983.

History: 1980, Act 524, Eff. Jan. 1, 1983.

SECTION 00620 - APPLICATION FOR PAYMENT CERTIFICATE

CONTRACTOR'S APPLICATION FOR PAYMENT NO. _____

CONTRACTOR: _____ TITLE: _____

OWNER: _____ CONTRACT NO.: _____

Substantial Completion Date: _____ Final Completion Date: _____

Milestone Completion Date: _____

Application is made for payment for the Work shown below, accomplished through the date of _____

1. Original Contract Sum		\$	_____
2. Net Change by Change Order		\$	_____
3. Current Contract Amount (line 1 + line 2)		\$	_____
4. Work Complete (from summary sheet)	_____ %	\$	_____
5. Stored Materials (from summary sheet, if applicable)		\$	_____
6. Less _____ % Retainage		\$	_____
7. Less 10% Retainage - Stored Materials		\$	_____
8. Total Retainage (line 6 + 7)		\$	_____
9. Amount Due to Date (line 4 + 5 - 8)		\$	_____
10. Less Previous Payments (from summary sheet)		\$	_____
11. Amount Due This Application (line 9-10)		\$	_____

CONTRACTOR'S Certification:

The undersigned CONTRACTOR certifies that: (1) all previous progress payments received from OWNER on account of Work done under the Contract referred to above have been applied to discharge in full all obligations of CONTRACTOR incurred in connection with Work covered by prior Applications for Payment; (2) title to all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to OWNER at time of payment free and clear of all liens, claims, security interest and encumbrances (except such as are covered by Bond acceptable to OWNER indemnifying OWNER against any such lien, claim, security interest or encumbrance); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and not defective as that term is defined in the Contract Documents.

ATTACHMENTS TO THIS CERTIFICATION:

____ Summary Sheet ____ Change Order Summary ____ Stored Material Summary
____ Other _____

CONTRACTOR:

By: _____ Date: _____

Payment to CONTRACTOR of the amount shown in line 11 above is recommended by ENGINEER, Tetra Tech, Inc.

By: _____ Date: _____

APPROVED: OWNER

By: _____ Date: _____

Change Order Summary

No.	Date	Additions	Deductions
	Subtotals		
Total Change In Contract Price			

SAMPLE

Stored Material Summary

Invoice No.	Stored Material	Material Location	Insurance Certificates on File	Stored Previous		Stored This Month		Incorporated This Month		Materials remaining in storage (\$)
				Date (MO/YR)	Amount (\$)	Date (MO/YR)	Amount (\$)	Date (MO/YR)	Amount (\$)	
		On-Site Off-Site	Yes / No							
		On-Site Off-Site	Yes / No							
		On-Site Off-Site	Yes / No							

SAMPLE

SECTION 00623 - CERTIFICATES OF INSURANCE

Attach Certificates of Insurance to This Page.

SECTION 00625 - CERTIFICATE OF COMPONENT ACCEPTANCE

Contract _____
 Contract No. _____
 Date Issued: _____
 Specification Section No. _____
 Equipment Item: _____
 Manufacturer: _____
 Manufacturer's Representative: _____ Phone: _____
 Address: _____

The representative named above hereby approves the equipment installation, and certifies that:

1. The equipment has been properly installed and lubricated.
2. The equipment is in accurate alignment.
3. The equipment is free from any undue stress imposed by connecting piping or anchor bolts.
4. The equipment has been operated under *full load conditions* and that it operated satisfactorily to ENGINEER.
5. OWNER's Representative has been instructed in the proper lubrication and operation of the equipment.
6. OWNER's Representative has been given a copy of all test data recorded during the installation check including speed, noise level, vibration, etc. (If no data was taken, so state below.)

The manufacturer's representative takes no exceptions to the above unless such exceptions are written below: (Continue on another sheet if required.)

Manufacturer's Representative	Date	Signature
-------------------------------	------	-----------

Witnesses:

Owner's Representative	Date	Signature
------------------------	------	-----------

Contractor's Representative	Date	Signature
-----------------------------	------	-----------

Engineer's Representative	Date	Signature
---------------------------	------	-----------

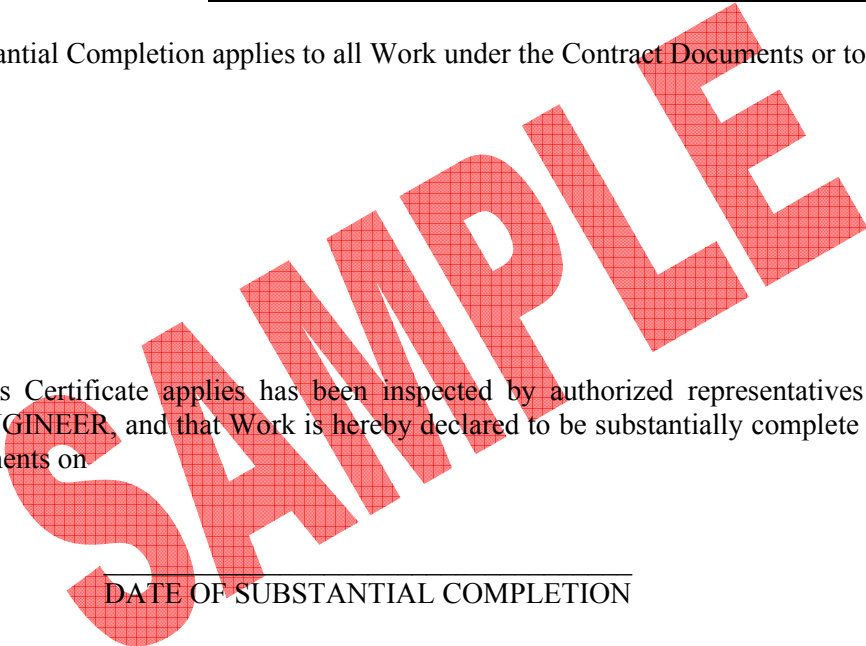
Owner	Date	Signature
-------	------	-----------

END OF SECTION

SECTION 00626 - CERTIFICATE OF SUBSTANTIAL COMPLETION

Contract _____
Contract No. _____
Date Issued: _____
OWNER _____
CONTRACTOR _____

This Certificate of Substantial Completion applies to all Work under the Contract Documents or to the following specified parts thereof:



The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on

DATE OF SUBSTANTIAL COMPLETION

A tentative list of items to be completed or corrected is attached hereto as Attachment No. A. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR within _____ days of the above date of Substantial Completion.

The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties and guarantees pending final payment shall be as follows:

OWNER: Shall perform and/or maintain insurances, if any, in accordance with Article 6 of the General Conditions, and allow CONTRACTOR reasonable access to complete or correct items on the tentative list. Additional responsibilities are:

CONTRACTOR: Shall perform and/or maintain Site security, temporary facilities, Bonds and insurances in accordance with Article 6 of the General Conditions, and protect the Work. Additional responsibilities are:

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

Attachment A: Tentative List of Items to be completed prior to Final Payment (Pages 1 to __, inclusive).

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

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Substantial Completion on _____
Date

CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Substantial Completion on _____
Date

OWNER

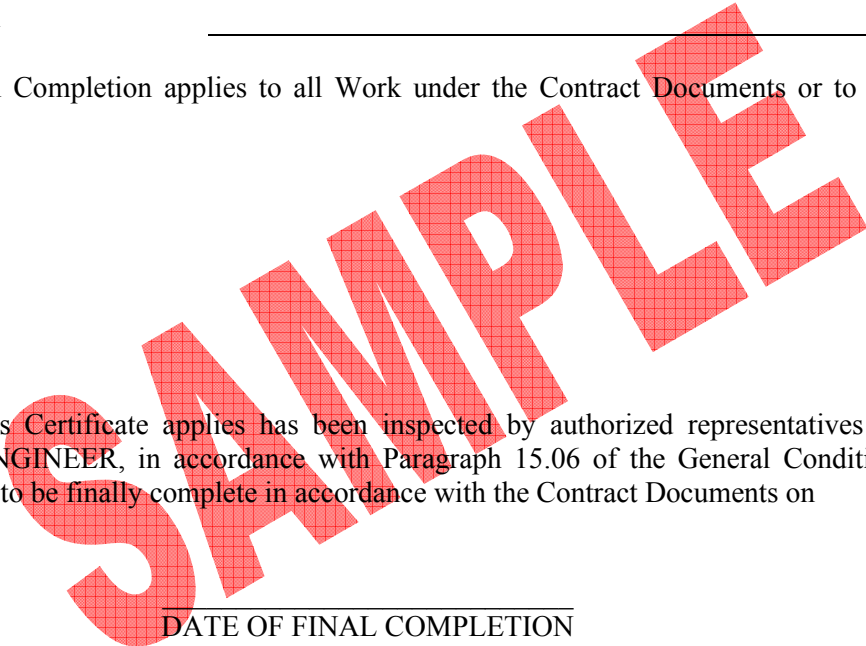
By: _____
(Authorized Signature)



SECTION 00627 - CERTIFICATE OF FINAL COMPLETION

Contract _____
Contract No. _____
Date Issued: _____
OWNER _____
CONTRACTOR _____

This Certificate of Final Completion applies to all Work under the Contract Documents or to the following specified parts thereof:



The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, in accordance with Paragraph 15.06 of the General Conditions, and that Work is hereby declared to be finally complete in accordance with the Contract Documents on

DATE OF FINAL COMPLETION

CONTRACTOR's general warranty and guarantee period commences on _____ and terminates on _____.

CONTRACTOR's special warranty and guarantee are:

_____ warranty and guarantee period commences on _____ and terminates on _____.

_____ warranty and guarantee period commences on _____ and terminates on _____.

This certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of CONTRACTOR's obligation to correct defective Work in accordance with the General Conditions of the Contract Documents.

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Final Completion on _____
Date

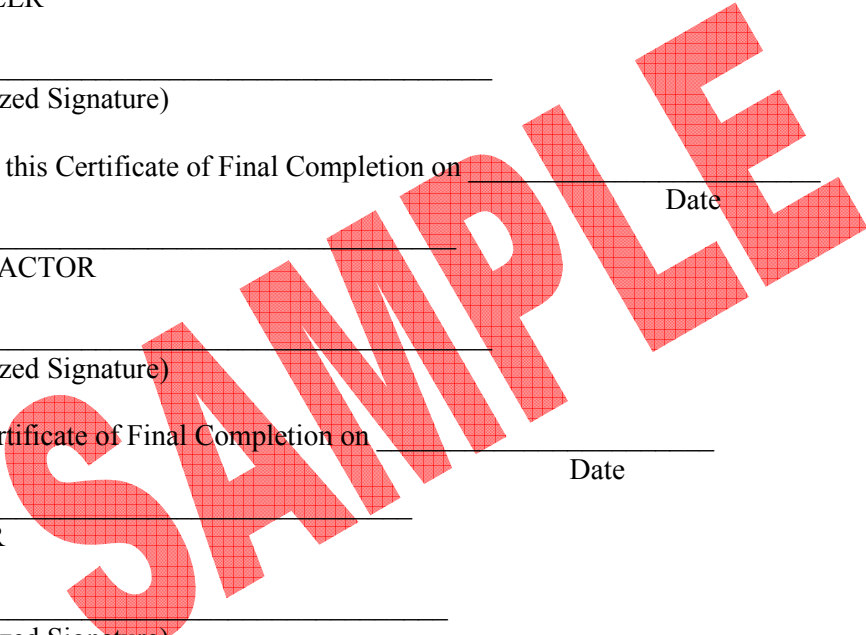
CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Final Completion on _____
Date

OWNER

By: _____
(Authorized Signature)



SECTION 00700 - GENERAL CONDITIONS

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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 form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting 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, or both; 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, or both; 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; or (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. 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), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. (“CERCLA”); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. (“RCRA”); (d) the Toxic Substances Control Act, 15 U.S.C. §§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree 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 the 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. *Engineer*—The individual or entity named as such in the Agreement.
21. *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.
22. *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. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.
23. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
25. *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.

26. *Notice of Award*—The written notice by Owner to a Bidder of Owner’s acceptance of the Bid.
27. *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.
28. *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.
29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.
30. *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.
31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.
32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or “RPR” includes any assistants or field staff of Resident Project Representative.
33. *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.
34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals and the performance of related construction activities.
35. *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.
36. *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.
37. *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 furnished by Owner which are designated for the use of Contractor.
38. *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.
39. *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.
40. *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 thereof.

41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.
42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, 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.
44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.
45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
46. *Unit Price Work*—Work to be paid for on the basis of unit prices.
47. *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.
48. *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 the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. *Intent of Certain Terms or Adjectives*:
 1. 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:*

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective:*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. 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 15.04).

E. *Furnish, Install, Perform, Provide:*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean 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, shall mean 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, shall mean 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. 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 Bonds and Evidence of Insurance

- A. *Bonds:* When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

- B. *Evidence of Contractor's Insurance*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.
- C. *Evidence of Owner's Insurance*: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), 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 executed 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 specifically 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 *Initial 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 for acceptability to Engineer

as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall 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.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.
- B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items 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 items, or from those established in applicable transmittal protocols.

ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one 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 or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall 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.

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, shall mean 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, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, 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, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, 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 Documents 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 Documents 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 shall 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 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 thereunder.
- 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 give written notice to Owner and Contractor 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 editions, 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 shall preclude 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 thirtieth 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 sixtieth day after the day of Bid opening or the thirtieth 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 shall 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 shall 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 shall 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 the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the 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. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall 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 utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and

- 4. acts of war or terrorism.
- D. 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.
- E. Paragraph 8.03 governs 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.
- F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times 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.
- G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor 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; 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 7.12, 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 at law; 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 shall 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 known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;
 - 2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); 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 upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. 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; or

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.

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 either:
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; or
 2. is of such a nature as to require a change in the Drawings or Specifications; or
 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 the necessity of Owner's obtaining 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 above; 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. *Possible Price and Times Adjustments:*
1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, 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 conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
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; or
 - 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 as 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, or both, then any such adjustment shall 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, or both, 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.

5.05 *Underground Facilities*

- A. *Contractor's Responsibilities:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:
 1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and
 2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
 - b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;
 - c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
 - d. 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 in the Contract Documents, or was not shown or indicated 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), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

- C. *Engineer's Review*: Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; 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 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. *Possible Price and Times Adjustments*:
 - 1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, 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. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;
 - 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;
 - c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and
 - d. 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, or both, then any such adjustment shall 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, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 *Hazardous Environmental Conditions at Site*

- A. *Reports and Drawings*: The Supplementary Conditions identify:
 - 1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
 - 2. 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 Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. 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; or
 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, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, 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.

- 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 or 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.H shall obligate 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 shall obligate 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 all of Contractor's obligations under the Contract. These bonds shall 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 Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.
- B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring

Companies” as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, 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 shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

- C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.
- D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.
- E. 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.
- F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

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. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverages, and endorsements 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 and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.
- D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements 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 and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.
- E. 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, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

- F. If either party does not purchase or maintain all of 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.
- G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.
- H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect 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 shall be adjusted accordingly.
- I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.
- J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 *Contractor's Insurance*

- A. *Workers' Compensation*: Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:
 - 1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.
 - 2. United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).
 - 3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).
 - 4. Foreign voluntary worker compensation (if applicable).
- B. *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:
 - 1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.
 - 2. claims for damages insured by reasonably available personal injury liability coverage.
 - 3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
- C. *Commercial General Liability—Form and Content*: Contractor's commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:
 - 1. Products and completed operations coverage:
 - a. Such insurance shall 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, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
 3. Broad form property damage coverage.
 4. Severability of interest.
 5. Underground, explosion, and collapse coverage.
 6. Personal injury coverage.
 7. 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); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.
 8. 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.
- D. *Automobile liability*: Contractor shall purchase and maintain automobile liability insurance against claims 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 shall be written on an occurrence basis.
- E. *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. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.
- F. *Contractor's pollution liability insurance*: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.
- G. *Additional insureds*: The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.
- H. *Contractor's professional liability insurance*: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

- I. *General provisions:* The policies of insurance required by this Paragraph 6.03 shall:
 - 1. include at least the specific coverages provided in this Article.
 - 2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.
 - 3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.
 - 4. remain in effect at least until final payment (and longer if expressly required in this Article) 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 Documents.
 - 5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed 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.
- J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.
- B. 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.

6.05 *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 full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:
 - 1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."
 - 2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement;

flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. 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 may be provided through other insurance policies acceptable to Owner and Contractor.

3. 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.
 4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).
 5. 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).
 6. extend to cover damage or loss to insured property while in transit.
 7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
 8. allow for the waiver of the insurer's subrogation rights, as set forth below.
 9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.
 10. not include a co-insurance clause.
 11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.
 12. include performance/hot testing and start-up.
 13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.
- B. *Notice of Cancellation or Change:* All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed 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.
- C. *Deductibles:* The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.
- 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 notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

- E. *Additional Insurance*: 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 6.05, it may do so at Contractor's expense.
- F. *Insurance of Other Property*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 *Waiver of Rights*

- A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers 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. 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 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 Subcontractors, all individuals or entities identified in the Supplementary Conditions as 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. None of the above waivers shall extend 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. 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:
 - 1. loss 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 perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner 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.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.

- D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work 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 any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 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 6.05 shall 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, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

7.01 *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. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 *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 at all times maintain good discipline and order at the Site.
- B. 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 shall 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.

7.03 *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 shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall 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 shall 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.

7.04 *“Or Equals”*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, 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 material or equipment, or items from other proposed suppliers under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an “or equal” item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) it 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) it has a proven record of performance and availability of responsive service; and
 - 4) it is not objectionable to Owner.
 - b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it 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 shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.
- E. *Treatment as a Substitution Request*: If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer considered the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 *Substitutes*

- A. Unless the specification or description of an item of material or equipment 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 material or equipment under the circumstances described below. To the extent possible such requests shall 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 material or equipment from anyone other than Contractor.
 - 2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.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 material or equipment that Contractor seeks to furnish or use. The application:
 - a. shall 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 that specified, and
 - 3) be suited to the same use as that 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 that specified, and
 - 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. shall 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 shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.
- B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities 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, Supplier, or other individual or entity 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 five days.

- E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. 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, Suppliers, or other individuals or entities 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, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.
- F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, 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, Supplier, or other individual or entity, whether initially or as a replacement, shall 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 fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.
- J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.
- K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.
- L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.
- N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.
- O. Nothing in the Contract Documents:
 - 1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor
 - 2. shall create 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.

7.07 *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 a particular 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 shall be disclosed by Owner 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.

7.08 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. 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

7.09 *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.

7.10 *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. Except where otherwise expressly required by applicable Laws and Regulations, 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 shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

- C. Owner or Contractor may give 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 notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 *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.

7.12 *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. 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.
- B. 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. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when 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.
- C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.
- D. 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.

- E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.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).
- F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).
- G. Contractor's duties and responsibilities for safety and protection shall 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.

7.13 *Safety Representative*

- A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of 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 threatened 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 thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

7.16 *Shop Drawings, Samples, and Other Submittals*

A. *Shop Drawing and Sample Submittal Requirements:*

1. Before submitting a Shop Drawing or Sample, Contractor shall have:
 - a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - c. determined and verified 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

- d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
 2. Each submittal shall 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 submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.
- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.
1. *Shop Drawings:*
 - a. Contractor shall submit the number of copies required in the Specifications.
 - b. Data shown on the Shop Drawings will 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.D.
 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.D.
 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. *Other Submittals:* Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.
- D. *Engineer's Review:*
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. 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, conform to the information given in 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 shall 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.
5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 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, shall 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, Sample, or other submittal shall 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.D.4.

E. *Resubmittal Procedures:*

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 submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

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 and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 1. abuse, modification, or improper 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.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is

not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

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. any inspection, test, or approval by others; or
 8. any correction of defective Work by Owner.
- D. 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 shall 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 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 performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom 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 shall 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.
- C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

7.19 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.
- B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.
- E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.

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

- D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, 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.

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 at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner 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, or both. 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 shall 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. When applicable, any such equitable adjustment in Contract Price shall 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 is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- 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. 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 to 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.
- C. 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 to Contractor.

- D. 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 shall 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 Documents (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 10.08. 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 *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 Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 *Rejecting Defective Work*

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

10.05 *Shop Drawings, Change Orders and Payments*

- A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.
- B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.
- C. Engineer's authority as to Change Orders is set forth in Article 11.
- D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 *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.

10.07 *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.

10.08 *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, shall 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 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 10.08 shall also apply to the Resident Project Representative, if any.

10.09 *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 (if any) of which Engineer has been informed.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
 - 1. *Change Orders:*
 - a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.
 - b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not 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, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.
 - 2. *Work Change Directives:* 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 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.
 - 3. *Field Orders:* 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. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 *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. Such changes shall be supported by Engineer's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes 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 shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate 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.

11.03 *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.

11.04 *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 shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall 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); or
 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 11.04.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 11.04.C).
- C. *Contractor's Fee:* When applicable, the Contractor's fee for overhead and profit shall 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 shall be 15 percent;

- b. for costs incurred under Paragraph 13.01.B.3, the Contractor's fee shall be five 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 11.01.C.2.a and 11.01.C.2.b is that the Contractor's fee shall be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.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 five 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 shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;
- d. no fee shall 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 will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 *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 shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.
- B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 *Change Proposals*

- A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.
 - 1. *Procedures:* Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. 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. The supporting data shall 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. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.
 - 2. *Engineer's Action:* Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve

it in whole, or deny it in part and approve it in part. Such actions shall 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.

3. *Binding Decision:* Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

B. *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 that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. changes in the 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 11.02, (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 in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 *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 shall be submitted 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; and
 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.
- 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 shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall be incorporated in a Change Order 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. 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 shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall 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. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, 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, shall 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 shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall 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, who 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 shall 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 for services specifically related to the Work.

5. Supplemental costs including 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, and hand tools not owned by the workers, 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.
 - c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - 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 property insurance established in accordance with Paragraph 6.05), 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 shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall 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 shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety 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. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
 4. 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.
 5. 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*: When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.
- E. *Documentation*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

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 on account of any of the foregoing will be valid.
- C. *Contingency Allowance*: Contractor agrees that a 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 on account of Work covered by allowances, and the Contract Price shall 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, subject to the provisions of the following paragraph.
- E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:
 - 1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;
 - 2. there is no corresponding adjustment with respect to any other item of Work; and
 - 3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

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 will 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 therewith 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 shall 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 shall 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 shall 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 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 shall 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 special 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, or both, 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 shall 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 rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven 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 on account of 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. 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 shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and 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.
 - 2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
 - 3. 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, or
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, 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 on account of Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of 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 that would constitute a default by Contractor and therefore justify a termination for cause has occurred;
 - j. liquidated 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;
 - l. there are other items entitling 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 shall 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 shall be treated as an amount due as determined by Paragraph 15.01.C.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 seven 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 shall 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 seven 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 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 6.05 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 7.11), and other documents, Contractor may make application for final payment.

2. The final Application for Payment shall 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 disputes that Contractor believes are unsettled; 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 Application and Acceptance:

1. 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 ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall 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. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. 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. 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.

D. Payment Becomes Due: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 *Waiver of Claims*

- A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.
- 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 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 terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then 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 other adjacent areas;
 - 2. correct such defective Work;
 - 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, 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 therefrom.
- B. If 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 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 correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).
- C. 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.
- D. 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.
- E. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph shall not 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, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall 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) ten 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) 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 seven 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 shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate For Convenience*

- A. Upon seven 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 on account of loss of anticipated overhead, profits, or revenue, 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 seven 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, seven 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; and
 2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising 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; or
 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 Documents requires the giving of written notice, it will be deemed to have been validly given if:
1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or
 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

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 shall not constitute a waiver of that provision, nor shall 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 or completion of the Contract or termination 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 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

SECTION 00800-SUPPLEMENTARY CONDITIONS

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INTRODUCTION

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2013 Edition). All provisions that are not so amended or supplemented remain in full force and effect.

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 thereto.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

SC-1.01 Defined Terms

SC-1.01. Add to the list of definitions in Paragraph 1.01.A by inserting the following as numbered items in their proper alphabetical positions:

Compensable Delay - Any delay beyond the control and without the fault or negligence of the CONTRACTOR resulting from OWNER-caused changes in the Work, differing site conditions, suspensions of the Work, or termination for convenience by the OWNER.

Excusable Delay - Any delay beyond the control and without the fault or negligence of the CONTRACTOR, the OWNER, or any other contractor caused by events or circumstances such as, but not limited to, acts of God or of the public enemy, acts of interveners, acts of the government, fires, floods, epidemics, quarantine restrictions, freight embargoes, and hurricanes, tornadoes, or new sink holes. Labor disputes and above average rainfall shall give rise only to Inexcusable Delays.

Float or Slack Time - The time available in the progress schedule during which an unexpected activity can be completed without delaying the Substantial Completion of the Work.

Geotechnical Baseline Report (GBR) — The interpretive report prepared by or for Owner regarding subsurface conditions at the Site, and containing specific baseline geotechnical conditions that may be anticipated or relied upon for bidding and contract administration purposes, subject to the controlling provisions of the Contract, including the GBR's own terms. The GBR is a Contract Document.

Geotechnical Data Report (GDR) — The factual report that collects and presents data regarding actual subsurface conditions at or adjacent to the Site, including Technical Data and other geotechnical data, prepared by or for Owner in support of the Geotechnical Baseline Report. The GDR's content may include logs of borings, trenches, and other site investigations, recorded measurements of subsurface water levels, the results of field and laboratory testing, and descriptions of the investigative and testing programs. The GDR does not include an

interpretation of the data. If opinions, or interpretive or speculative non-factual comments or statements appear in a document that is labeled a GDR, such opinions, comments, or statements are not operative parts of the GDR and do not have contractual standing. Subject to that exception, the GDR is a Contract Document.

Inexcusable Delay - Any delay caused either (i) by events or circumstances within the control of the CONTRACTOR, such as inadequate crewing, slow submittals, etc., which might have been avoided by the exercise of care, prudence, foresight, or diligence on the part of the CONTRACTOR, (ii) by weather conditions (other than hurricanes and tornadoes) or (iii) labor disputes.

Nonprejudicial Delay - Any delay impacting a portion of the Work within the available total Float or Slack Time, as that term is used in Section 01310: Progress Schedules and not necessarily preventing completion of the Work within the Contract Time.

Prejudicial Delay - Any Excusable or Compensable Delay impacting the Work and exceeding the total Float Time available in the progress schedule, thus preventing completion of the Work within the Contract Time unless the Work is accelerated.

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.05 Initial Acceptance of Schedules

SC-2.05 Add the following new paragraph 2.05.A.2

2.05.A.2 CONTRACTOR'S schedule of shop drawings and sample submittals will be acceptable to ENGINEER only if it provides a minimum of thirty (30) days for reviewing and processing the submittals. Shop Drawings requiring resubmission and review shall not rise to an excusable delay.

ARTICLE 3 - DOCUMENTS: INTENTS, REQUIREMENTS, REUSE

SC-3.03 Reporting and Resolving Discrepancies

SC-3.03 Delete paragraph 3.03 A.3 of the General Conditions in its entirety and replace with the following:

3.03 A.3 Measurements

1. When measurements are affected by conditions already established or where items have to be fitted into construction conditions, it shall be the CONTRACTOR's responsibility to verify all such dimensions at the site and the actual job dimensions shall take precedence over scale and figure dimensions on the Drawings.

2. The CONTRACTOR shall carefully study and compare all Drawings, Specifications and other instructions; shall test all figures on the Drawings before laying out the Work; shall notify the ENGINEER of all errors, inconsistencies, or omissions which he may discover; and obtain specific instructions before proceeding with the Work. The CONTRACTOR shall not take advantage of any apparent error or omissions which may be found in the Contract Documents, and the ENGINEER shall be entitled to make such corrections therein and interpretations thereof as may be deemed necessary for the fulfillment of their intent. The CONTRACTOR shall be responsible for all errors in construction which could have been avoided by

such examination and notification and shall correct, at CONTRACTORS own expense, all Work improperly constructed through failure to notify the ENGINEER and request specific instructions.

ARTICLE 4 - COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.01 Commencement of Contract times; Notice to Proceed

SC-4.01 A. Delete Paragraph 4.01 in its entirety and replace it with:

4.01 The Contract Time will commence to run on the day indicated in the Notice to Proceed. The Notice to Proceed may be given at any time after the Effective Date of the Agreement.

SC-4.05 Delays in Contractor's Progress

SC-4.01 A. Delete the words, "and Contract Price" at the end of the first sentence.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.04 Differing Subsurface or Physical Conditions

SC-5.04.A.4 Replace, "promptly" with, "within three (3) days" in the first line that follows subparagraph 4.

SC-5.05 Underground Facilities

SC-5.05.B.1 In the first sentence of 5.05.B.1 replace, "promptly" with, "within three (3) days".

ARTICLE 6 – BONDS AND INSURANCE

SC-6.02 Insurance—General Provisions

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker's compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the project is located, (b) is certified or authorized as a worker's compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker's compensation insurance for similar projects by the state within the last 12 months.

SC-6.03 Contractor's Liability Insurance

SC 6.03 Add the following new paragraph immediately after Paragraph 6.03.J:

- K. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs 6.03.A.1 and A.2 of the General Conditions:

State:	<u>Statutory</u>
Federal, if applicable (e.g., Longshoreman's):	<u>Statutory</u>
Jones Act coverage, if applicable:	
Bodily injury by accident, each accident	\$ <u>1,000,000</u>
Bodily injury by disease, aggregate	\$ <u>1,000,000</u>

Employer's Liability:

Bodily injury, each accident	\$ <u>3,000,000</u>
Bodily injury by disease, each employee	\$ <u>3,000,000</u>
Bodily injury/disease aggregate	\$ <u>3,000,000</u>

For work performed in monopolistic states, stop-gap liability coverage shall be endorsed to either the worker's compensation or commercial general liability policy with a minimum limit of:

\$ 1,000,000

Foreign voluntary worker compensation

Statutory

2. Contractor's Commercial General Liability under Paragraphs 6.03.B and 6.03.C of the General Conditions:

General Aggregate	\$ <u>2,000,000</u>
Products - Completed Operations Aggregate	\$ <u>2,000,000</u>
Personal and Advertising Injury	\$ <u>1,000,000</u>
Each Occurrence (Bodily Injury and Property Damage)	\$ <u>1,000,000</u>

3. Automobile Liability under Paragraph 6.03.D. of the General Conditions:

Bodily Injury:

Each person	\$ <u>1,000,000</u>
Each accident	\$ <u>1,000,000</u>

- | | |
|---|---|
| Property Damage: | |
| Each accident | \$ <u>1,000,000</u> |
| | <i>[OR]</i> |
| Combined Single Limit of | \$ <u>2,000,000</u> |
| 4. Excess or Umbrella Liability: | |
| Per Occurrence | \$ <u>3,000,000</u> |
| General Aggregate | \$ <u>3,000,000</u> |
| 5. Contractor's Pollution Liability: | |
| Each Occurrence | \$ <u>1,000,000</u> |
| General Aggregate | \$ <u>2,000,000</u> |
| 6. Additional Insureds: Include as additional insureds the following: | |
| a. | City of Mt. Clemens, MI, and including all elected and appointed officials, all employees and volunteers, all boards, commissions, and/or authorities and their board members, employees, and volunteers. |
| b. | Tetra Tech, Inc. and Tetra Tech of Michigan, PC |

SC-6.04 Owners Liability Insurance

SC-6.04. Delete section 6.04 and replace with the following:

In addition to the insurance required to be provided by Contractor under Paragraph 6.03, CONTRACTOR shall procure and maintain during the Contract Times a separate OWNER's and CONTRACTOR's Protective (OCP) Liability Insurance in the name of the OWNER in an amount not less than \$1,000,000 for injuries, including accidental death for each occurrence, and property damage in an amount not less than \$500,000 each occurrence and \$1,000,000 per contract aggregate combined single limit. Tetra Tech, Inc. and Tetra Tech of Michigan, PC shall be named on the policy as an additional insured.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.01 Supervision and Superintendence

SC-7.02.B. Add the following to the end of Paragraph 7.02.B, "Resident Superintendent shall be fluent in English."

SC-7.04 "Or Equals"

SC-7.04.A. Delete the first paragraph in 7.04.A of the General Conditions in its entirety and insert the following in its place:

7.04.A ENGINEER and OWNER have no obligation to consider "or equal" items or substitutions unless such items are specifically identified in Section 00435-Subcontractor and Product List by CONTRACTOR at the time of bid. All "or equal" items and substitute items must be identified at the time of bid. It is the

OWNER's sole prerogative to have ENGINEER review proposals, other than those identified in Section 00435, proposed by CONTRACTOR during the course of the Work. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function and quality required. Unless the specification or description contains or is followed by words "or equal" or "or approved equal" no substitution is permitted. Other items of material or equipment of other Suppliers will be reviewed by ENGINEER, with OWNER's approval, if the material or equipment is not named in Section 00435.

SC-7.06 Concerning Subcontractors, Suppliers and Others

SC-7.06.D. In the last sentence of the paragraph replace “five days” with “ten days.”

SC-7.08 Permits

SC-7.08.A. Replace entire section with:

Contractor will apply and obtain all needed construction permits. Owner will pay for trade permits and environmental permits.

SC-7.20 Reimbursing Owner's Costs

SC-7.20. Add the following after paragraph 7.19:

7.20 Additional Costs: Contractor shall reimburse Owner for services rendered by the Engineer when made necessary by any of the following:

7.20.1. Work damaged by fire, flood, collapse, or any other cause during construction.

7.20.2. Default by Contractor or any Subcontractor.

ARTICLE 10 – ENGINEER’S STATUS DURING CONSTRUCTION

SC-10.03 Project Representative

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

- B. The Resident Project Representative (RPR) will be Engineer's representative at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR's actions.
 - 1. General: RPR's dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor. RPR shall generally communicate with Owner only with the knowledge of and under the direction of Engineer.
 - 2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.

3. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.
4. Liaison:
 - a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.
5. Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.
6. Shop Drawings and Samples:
 - a. Record date of receipt of Samples and Contractor-approved Shop Drawings.
 - b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.
 - c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.
7. Modifications: Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.
8. Review of Work and Rejection of Defective Work:
 - a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Report to Engineer whenever RPR believes that any part of Contractor's work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
9. Inspections, Tests, and System Start-ups:
 - a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's personnel, and that Contractor maintains adequate records thereof.

- b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.
10. Records:
- a. Prepare a daily report or keep a diary or log book, recording Contractor's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.
 - b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.
 - c. Maintain records for use in preparing Project documentation.
11. Reports:
- a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.
 - b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.
 - c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.
12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.
13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.
14. Completion:
- a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.
 - b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and Contractor, and prepare a final punch list of items to be completed and deficiencies to be remedied.
 - c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

- C. The RPR shall not:
1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including “or-equal” items).
 2. Exceed limitations of Engineer’s authority as set forth in the Contract Documents.
 3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.
 4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor’s work.
 5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.
 6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
 7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.
 8. Authorize Owner to occupy the Project in whole or in part.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

SC-11.02 Owner-Authorized Changes in the Work

SC-11.02 B & C Add the following new paragraphs B and C after 11.01.A

SC-11.01.B At anytime, ENGINEER may request a quotation from CONTRACTOR for a proposed change in the Work. Within seven (7) calendar days after receipt of a request for a quotation for a proposed change, the CONTRACTOR shall submit a written and detailed proposal for an increase or decrease in the Contract Price or Contract Time for the proposed change. ENGINEER shall have twenty-one (21) calendar days after receipt of the detailed proposal to respond in writing. The proposal shall include an itemized estimate of all costs and time for performance that will result directly or indirectly from the proposed change. Unless otherwise directed, itemized estimates shall be in accordance with Articles 11 and 12 of the General Conditions and in sufficient detail to permit an analysis by ENGINEER of all material, labor, equipment, subcontract, and overhead costs and fees and shall cover all Work involved in the change, whether such Work was deleted, added, changed, or impacted. Any amount claimed for subcontracts shall be similarly supported. Itemized schedule adjustments shall be in sufficient detail to permit an analysis of impact as required in Section 01310: Progress Schedules. Notwithstanding the request for quotation, the CONTRACTOR shall carry on the Work and maintain the progress schedule.

SC-11.02.C The adjustment in Contract Price and/or Contract Time stated in a Change Order shall comprise the total price and/or time adjustment due or owed the CONTRACTOR for the Work or changes defined in the Change Order. By executing the Change Order, the CONTRACTOR acknowledges and agrees that the stipulated price and/or time adjustments include the costs and delays for all Work contained in the Change Order, including costs and delays associated with the interruption of schedules, extended overheads, delay, acceleration and cumulative impacts or ripple effect on all other non-affected Work under this contract. Signing of the Change Order constitutes full and mutual accord and satisfaction for the adjustment in the Contract Price or Contract Time as a result of increases or decreases in costs and time of performance caused directly and indirectly from the change, subject to the current scope of the

entire Work as set forth in the Contract Documents. Acceptance of the Change Order constitutes an agreement between OWNER and CONTRACTOR that the Change Order represents an equitable adjustment to the Contract Documents, and that the CONTRACTOR will waive all rights to file a claim on this Change Order after it is properly executed.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

SC-13.03 Unit Price Work

SC 13.03.E Delete Paragraph 13.03.E in its entirety and insert the following in its place:

- E. The unit price of an item of Unit Price Work shall be subject to reevaluation and adjustment under the following conditions:
 - 1. if the extended price of a particular item of Unit Price Work amounts to 5 percent or more of the Contract Price (based on estimated quantities at the time of Contract formation) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement; and
 - 2. if there is no corresponding adjustment with respect to any other item of Work; and
 - 3. if Contractor believes that Contractor has incurred additional expense as a result thereof, Contractor may submit a Change Proposal, or if Owner believes that the quantity variation entitles Owner to an adjustment in the unit price, Owner may make a Claim, seeking an adjustment in the Contract Price.

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

SC-15.01 Progress Payments

SC 15.01.D. In the first sentence, delete “Ten” and insert “Thirty” in its place.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

SC-16.03 Owner May Terminate for Convenience

SC 16.03.A. Add the following new paragraph 16.03.A.4:

- 4. Such sums will be due and payable on the same conditions as set forth for final payment to the extent applicable. Upon receipt of such payment, the parties hereto shall have no further obligations to each other except for the Contractor’s obligations to perform corrective and/or warranty work and to indemnify the Owner as provided for in the Contract Documents.

SC 16.03.C. Add the following new paragraph 16.03.C:

- C. Termination by Owner as provided in this section shall not obviate, release or otherwise waive any claims the Owner possesses against insurance policies maintained by the Contractor.

SC 16.03.A. Add the following new paragraph 16.03.D:

- D. The Contractor agrees that each subcontract and purchase order issued by it will reserve for the Contractor the same right of termination provided by this section, and the Contractor

further agrees to require that comparable provisions be included in all lower tier subcontracts and purchase orders.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

SC-17.02 Add the following new paragraph immediately after Paragraph 17.01.

SC-17.02 Arbitration

- A. All matters subject to final resolution under this Article will be decided by arbitration in accordance with the rules of *the American Arbitration Association*, subject to the conditions and limitations of this paragraph. This agreement to arbitrate and any other agreement or consent to arbitrate entered into will be specifically enforceable under the prevailing law of any court having jurisdiction.
- B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitrator or arbitration provider, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in this Article, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event shall any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations. The demand for arbitration should include specific reference to Paragraph SC-17.02.D below.
- C. No arbitration arising out of or relating to the Contract shall include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:
 1. the inclusion of such other individual or entity is necessary if complete relief is to be afforded among those who are already parties to the arbitration; and
 2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration and which will arise in such proceedings.
- D. The award rendered by the arbitrator(s) shall be consistent with the agreement of the parties, in writing, and include a concise breakdown of the award, and a written explanation of the award specifically citing the Contract provisions deemed applicable and relied on in making the award.
- E. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.
- F. The fees and expenses of the arbitrators and any arbitration service shall be shared equally by Owner and Contractor.

ARTICLE 18 – MISCELLANEOUS

SC-18.01 *Giving Notice*

SC-18.01 Add the following new paragraph immediately after Paragraph 18.01.A.2.:

"3. Delivered by an independent carrier than can substantiate delivery with a tracking number and name of an individual or member of the firm accepting receipt."

SC-SC-18.07 Controlling Law

SC-18.07 Add the following new paragraphs immediately after Paragraph 18.07 A.:

- B. In accordance with Section 209 of the Elliott-Larsen Civil Rights Act, a Contract to which the State, a political subdivision, or an agency thereof is a party shall contain a covenant by CONTRACTOR and his subcontractors not to discriminate against an Employee or Applicant for employment with respect to hire, tenure, conditions, or privileges of employment, or a matter directly or indirectly related to employment because of race, color, religion, national origin or ancestry, age, sex, height, weight, or marital status. Breach of this covenant may be regarded as a material breach of the Contract.

SC-18.09 Funding Agency Requirements

- A. OWNER will require the use of prevailing wage rates on this Project. CONTRACTOR must comply with:
 - 1. Section 00450 - Prevailing Wage Rates, General Decision Number MI20230091, dated 01/19/2024.

END OF SECTION

SECTION 01110 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. The Project is located at the Mt Clemens Wastewater Treatment Plant, 1750 Clara Ave, Mt Clemens, MI 48043.
- B. The Work primarily consists of improvements to the WWTP including replacement of the waste return activated sludge pumping, installation of new solids handling equipment, and electrical and instrumentation improvements. The solids handling screw presses, conveyors, polymer blending units and control panels have been pre-purchased. Work also includes the demolition of existing sludge handling equipment and piping.

1.02 WORK SEQUENCE

- A. CONTRACTOR shall arrange its Work so that at no time shall it cause unnecessary interruption to the operation of existing facilities. When construction operations must be done with any portion of the existing facilities out of service, such Work shall be done at such times and in the sequence as recommended by ENGINEER and with the prior approval of the Michigan Department of Environment, Great Lakes, and Energy (EGLE), if required. During such period of curtailment of facility operation, the Work shall be done with all haste possible under the circumstances, even to the extent of working continuously 24 hours a day for this period. A suggested sequence of construction is as follows:
 - 1. Install new solids handling equipment in existing Solid Handling building garage.
 - 2. Modify existing pipe in solids handling building while maintain existing system operation
 - 3. Replace existing waste activated sludge pumps and variable frequency drives
 - 4. Perform startup, testing and trail period operation of the new solids handling system.
 - 5. Remove existing solids handling equipment and piping.
- B. If CONTRACTOR wishes to propose an alternate sequence of construction for maintaining operation of existing facilities, CONTRACTOR shall submit complete details of its plan to ENGINEER for approval.

1.03 GENERAL CONSTRAINTS

- A. Electrical and broadband internet services shall be maintained to WWTP at all times.
- B. Influent flow and water service to the WWTP shall be maintained at all times.
- C. No interruptions of any part of the WWTP treatment process shall occur without the expressed prior approval of the OWNER and ENGINEER. Requests shall allow no less than 14 days for plant staff to make necessary arrangements to properly accommodate any required shutdowns. Longer periods may be required at the sole discretion of the OWNER. At no time will a process be allowed to be interrupted that may contribute to compromising effluent quality.

- D. The CONTRACTOR shall be completely responsible for fines or other enforcement imposed upon the OWNER facility resulting from inadvertent or unplanned treatment interruptions caused by the CONTRACTOR that result in NPDES permit violations.
- E. CONTRACTOR shall provide Drawings and other necessary details of temporary facilities for approval prior to purchase, installation, or interruption of any plant process.
- F. CONTRACTOR shall place matting over all tunnels, channels, tanks, and piping where heavy equipment will be travelling. CONTRACTOR shall also install shoring in tunnels and channels where heavy equipment will travel over. Extent of areas may not be shown on the drawings. Verify with Owner and Engineer before any large equipment is brought on site. Damage from construction activities will be the responsibility of CONTRACTOR to repair.
- G. In all tanks, wet wells, sump pits, and any other area on site where Work is to be performed, OWNER will drain down these areas with existing permanently installed equipment to the extent possible. No special arrangements (unless specifically noted below) by OWNER will be made to clean or keep tanks dry during construction. All remaining debris, water, and wastewater material in tank bottoms and that may be adhered to walls and ceilings shall be CONTRACTOR's responsibility to remove to the extent necessary to perform Work and provide safe and clean working areas.
- H. Valves and gates to existing processes shall only be operated by the OWNER.

1.04 SPECIFIC CONSTRAINTS

- A. At least one of the new sludge dewatering presses shall be operational on new pumping and piping system and operated error free before other sludge pump and piping modifications are begun.
- B. Demolition of existing solids handling equipment shall not occur until new system has operated 30 days error and alarm free.
- C. Existing solids handling system shall remain in service until completion of testing.

1.05 CONTRACTOR USE OF PREMISES

- A. Limit use of the premises to construction activities in areas indicated; allow for OWNER occupancy and use by the public. Confine operations to areas within Contract limits indicated. Portions of the Site beyond areas in which construction operations are indicated are not to be disturbed.
- B. Keep driveways and entrances serving the premises clear and available to OWNER, OWNER's employees, and private property owners at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on Site. Areas for CONTRACTOR's trailers, equipment, and material storage, and CONTRACTOR's employee parking shall be as indicated on Drawings or agreed by OWNER prior to the start of construction.

Vehicular access must be retained at all time to all parts of the plant for deliveries, waste disposal and emergency vehicle access purposes. This may require promptly backfilling trenches. CONTRACTOR will be responsible for constructing temporary access roads if the work renders existing driveways impassable.

- C. Use of the Existing Building: Maintain the existing buildings in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.
- D. CONTRACTOR shall keep parking areas and driveways free of debris. CONTRACTOR shall plan to sweep these surfaces throughout the project.

1.06 OWNER OCCUPANCY

- A. Full OWNER Occupancy: OWNER will occupy the Site and existing building during the entire construction period. Cooperate with OWNER during construction operations to minimize conflicts and facilitate OWNER usage. Perform the Work so as not to interfere with OWNER's operations.
- B. Partial OWNER Occupancy: OWNER reserves the right to occupy and to place and install equipment in completed areas of the building, prior to Substantial Completion provided that such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
- C. A Certificate of Substantial Completion shall be executed for each specific portion of the Work to be occupied prior to OWNER occupancy.
- D. Obtain a Certificate of Occupancy from local building officials prior to OWNER occupancy.
- E. Prior to partial OWNER occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, OWNER will provide operation and maintenance of mechanical and electrical systems in occupied portions of the building.

1.07 MISCELLANEOUS PROVISIONS

- A. CONTRACTOR shall notify all Owners of public utilities within the right-of-way or easement for the purpose of establishing the approximate locations of the utilities in accordance with the requirements of Act No. 53 Public Acts of 1974 of the State of Michigan. CONTRACTOR shall notify MISS DIG-Utility Communication System, 1-800-482-7171, three working days prior to starting any excavation with power equipment.
- B. CONTRACTOR shall be responsible for verifying the location of all underground utilities by magnetic or other type instruments before beginning excavation Work.
- C. Time and Sequence of Work: In general, it is the intention and understanding that CONTRACTOR shall have control over the sequence or order of execution of the several parts of the Work to be done under the Contract and over the method of accomplishing the required results, except as some particular sequence or method may be distinctly demanded by the Drawings and Project Manual or by the expressed provisions of the Contract. ENGINEER may, however, make such reasonable requirements as may, in ENGINEER's judgment, be necessary for the proper and effective protection of Work partially or wholly completed, and to these requirements CONTRACTOR shall conform.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01230 - ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Alternates.

1.02 DEFINITIONS

- A. Alternate: An amount proposed by Bidders and stated on Bid Form for certain construction activities defined in the Bidding Requirements that may be added to or deducted from Base Bid amount if OWNER decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1.03 OWNER'S INSTRUCTIONS

- A. Coordinate related Work and modify or adjust adjacent Work as necessary to ensure that Work affected by each accepted Alternate is complete and fully integrated into the Project.
- B. OWNER will evaluate Bids from the Base Lump Sum Bid price, and add or deduct the amounts stated on Bid Form for the Alternate in the order in which the Alternates are listed on Schedule at the end of this Section. OWNER reserves the right to determine how many Alternates will be added or deducted for this Project. The cost of the Alternate shall include any appropriate amounts for general conditions, bonds, insurances, materials, labor, tools, power, transportation, construction equipment, and associated items involved with the described Alternate.
- C. Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected, or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.
- D. A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced on the Schedule contain requirements for materials and methods necessary to achieve the Work described under each Alternate. Drawings referenced on the Schedule indicate the Work required to perform the Alternate.
- E. Include as part of each Alternate, miscellaneous devices, accessory objects, and similar items that are included with or required for a complete installation, whether or not mentioned as part of the Alternate.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

SCHEDULE OF ALTERNATES

Alternates to the Base Bid Form are offered as follows. Drawings and specification sections referenced are a general guide and may not be all inclusive of the work in the alternate and the referenced drawings and specifications may also apply to portions of the base work.

Alternate No. 1

Description: The alternate consists of deleting of the demolition of the existing equipment and sludge piping in the basement of the Solids Handling building. This includes existing sludge transfer pumps, blowers, equipment, existing polymer feed pump and pads, and piping from the project that is not necessary for piping modifications .

Reference Drawing No.DD101, DD102, DD103, DD301,

Alternate No. 2

Description: The alternate consists of deleting of the demolition of the existing aeration diffusers and mixers in the sludge storage tanks. This includes existing diffusers, headers, valves, air piping and submersible mixers.

Reference Drawing No.DD101, DD301,

Alternate No. 3

Description: The alternate consists of deleting of the proposed epoxy floor coating in the solids building garage.

Reference Drawing No.S102, Specification 09960

END OF SECTION

SECTION 01290 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements governing CONTRACTOR's Applications for Payment.
- B. Related Sections:
 - 1. CONTRACTOR's Application for Payment form is included in Section 00620.
 - 2. CONTRACTOR's Construction Schedule and Submittal Schedule are included in Section 01330.

1.02 OWNER'S INSTRUCTIONS

- A. Schedule of Values:
 - 1. Coordinate preparation of Schedule of Values with preparation of CONTRACTOR's Construction Schedule.
 - 2. Correlate line items on Schedule of Values with other required administrative schedules and forms, including:
 - a. CONTRACTOR's Construction Schedule.
 - b. Application for Payment form.
 - c. List of subcontractors.
 - d. Schedule of Allowances.
 - e. Schedule of Alternates.
 - f. List of products.
 - g. List of principal suppliers and fabricators.
 - h. Schedule of Submittals.
 - 3. Submit Schedule of Values to ENGINEER at the earliest feasible date, but in no case later than 7 days before the date scheduled for submittal of the initial Application for Payment.
 - 4. Format and Content: Use the Project Manual Table of Contents as a guide to establish the format for Schedule of Values.
 - 5. Identification: Include the following Project identification on Schedule of Values:
 - a. Project name and location.
 - b. Name of ENGINEER.
 - c. Project number.
 - d. CONTRACTOR's name and address.
 - e. Date of submittal.
 - 6. Arrange Schedule of Values in a tabular form with separate rows for each Specification Section and separate columns for each major structure or area of Work.
 - 7. Provide a breakdown of the Contract Price in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Break principal subcontract amounts down into several line items.
 - 8. Round off amounts to the nearest whole dollar; the total shall equal the Contract Price.
 - 9. For each part of the Work where an Application for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

10. Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually on Applications for Payment. Each item on Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.
 11. At CONTRACTOR's option, temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown as separate line items on Schedule of Values or distributed as general overhead expense.
 12. Update and resubmit Schedule of Values when Change Orders or Work Change Directives result in a change in the Contract Price.
- B. Initial Application for Payment: Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
1. List of subcontractors.
 2. List of principal suppliers and fabricators.
 3. Schedule of Values.
 4. CONTRACTOR's Construction Schedule (preliminary if not final).
 5. Schedule of principal products.
 6. Schedule of unit prices.
 7. Submittal Schedule (preliminary if not final).
- C. Applications For Payment:
1. Each Application for Payment shall be consistent with previous applications and payments as certified by ENGINEER and paid for by OWNER.
 2. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
 3. The date for each progress payment will be determined at the Pre-Construction Conference. The period of construction Work covered by each Application for Payment is 1 month. Actual start/end dates will be determined at the Pre-Construction Conference.
 4. Use the pay application form included in Section 00620 for Applications for Payment.
 5. Complete every entry on the form, including execution by person authorized to sign legal documents on behalf of CONTRACTOR. Incomplete applications will be returned without action.
 6. Entries shall match data on Schedule of Values and CONTRACTOR's Construction Schedule. Use updated Schedules if revisions have been made.
 7. Include amounts of Change Orders and Work Change Directives issued prior to the last day of the construction period covered by the application.
 8. Submit electronic copy of each Application for Payment to ENGINEER; the copy shall be complete, including waivers of lien, certified payroll and similar attachments, when required.
 9. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to ENGINEER.
- D. Application for Payment at Substantial Completion:
1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for OWNER occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall proceed or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.

- e. Meter readings.
 - f. Start-up performance reports.
 - g. Changeover information related to OWNER's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. Advice on shifting insurance coverages.
 - k. Final progress photographs.
 - l. List of incomplete Work, recognized as exceptions to ENGINEER'S Certificate of Substantial Completion.
- E. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
- 1. Completion of Project closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Assurance that unsettled claims will be settled.
 - 4. Assurance that Work not complete and accepted will be completed without undue delay.
 - 5. Transmittal of required Project construction records to OWNER.
 - 6. Proof that taxes, fees, and similar obligations have been paid.
 - 7. Removal of temporary facilities and services.
 - 8. Removal of surplus materials, rubbish, and similar elements.
 - 9. Change of door locks to OWNER's access.
 - 10. CONTRACTOR's waivers of mechanics liens for Project.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01310 - PROJECT COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:
 - 1. Coordination of Work under this Contract.
 - 2. Coordination with other Contractors.
 - 3. Administrative and supervisory personnel.
 - 4. Land survey work.
 - 5. Pre-Construction Conference.
 - 6. Pre-Excavation Conference.
 - 7. Pre-Installation Conference.
 - 8. Progress meetings.
 - 9. General installation provisions.
 - 10. Cleaning and protection.

- B. Related Sections Specified Elsewhere:
 - 1. Equipment installation check, and operation, maintenance, and training of OWNER's personnel are included in Section 01600 and Sections for specific equipment items.
 - 2. Requirements for CONTRACTOR's Construction Schedule are included in Section 01330.

1.02 DEFINITIONS

- A. Monument: The term "monument" shall be considered as any object defining the location of a property corner, street location, section line, fractional section line, right-of-way marker, or other delineation of land ownership or division.

1.03 SUBMITTALS

- A. Prior to Preconstruction Meeting submit a list of CONTRACTOR's principal staff assignments, including the Superintendent and other personnel in attendance at Site; identify individuals, their duties and responsibilities; list their addresses and telephone numbers

1.04 SCHEDULING

- A. Coordinate construction operations included under different Sections of the Specifications that are dependent upon each other for proper installation, connection, and operation. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair. Make adequate provisions to accommodate items scheduled for later installation.

- B. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at Site in accordance with Laws or Regulations. CONTRACTOR shall train CONTRACTOR's employees on use of these sheets and shall keep a master copy on hand at Site.

- C. Coordination with Other Contractors:
 - 1. CONTRACTOR shall so conduct CONTRACTOR's operations as not to interfere with or injure the Work of other Contractors or workmen employed on adjoining or related Work, and CONTRACTOR shall promptly make good any injury or damage which may be done to such Work by CONTRACTOR or CONTRACTOR's employees or agents.
 - 2. Should a contract for adjoining Work be awarded to another CONTRACTOR, and should the Work on one of these contracts interfere with that of the other, ENGINEER shall decide which contract shall cease Work for the time being and which shall continue, or whether Work on both contracts shall continue at the same time and in what manner.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of schedules.
 - 2. Installation and removal of temporary facilities.
 - 3. Delivery and processing of submittals.
 - 4. Progress meetings.
 - 5. Project closeout activities.

1.05 PRE-CONSTRUCTION CONFERENCE

- A. ENGINEER will schedule a Pre-Construction Conference and organizational meeting at the Site or other convenient location prior to commencement of construction activities to review responsibilities and personnel assignments, within 10 days of Notice of Award.
- B. Attendees: OWNER, ENGINEER and ENGINEER's consultants, CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
 - 1. Tentative Construction Schedule.
 - 2. Critical Work sequencing.
 - 3. Designation of responsible personnel.
 - 4. Procedures for processing field decisions and Change Orders.
 - 5. Procedures for processing Applications for Payment.
 - 6. Distribution of Contract Documents.
 - 7. Submittal of Shop Drawings, product data, and samples.
 - 8. Preparation of Record Documents.
 - 9. Use of the premises.
 - 10. Office, Work, and storage areas.
 - 11. Equipment deliveries and priorities.
 - 12. Safety procedures.
 - 13. First aid.
 - 14. Security.
 - 15. Housekeeping.
 - 16. Working hours.

1.06 PRE-EXCAVATION CONFERENCE

- A. In addition to the Pre-Construction Conference, ENGINEER may also require a Pre-Excavation Conference. CONTRACTOR and Subcontractors performing excavation Work on Site shall provide written descriptions of their plans for shoring, dewatering, disposal of spoils, protection of existing utilities, and any other particulars of the excavation process, including the technical basis for their selection of the means and methods to be employed. CONTRACTOR will prepare and distribute minutes before work commences.

1.07 PRE-INSTALLATION CONFERENCE

- A. Where specified, CONTRACTOR, supplier, and ENGINEER shall meet on Site and discuss tools, techniques, and procedures for installation of products and equipment prior to performing the Work.

1.08 PROGRESS MEETINGS

- A. Attendees: In addition to representatives of OWNER and ENGINEER, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.
- B. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the Project.
- C. CONTRACTOR's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to CONTRACTOR's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
- D. Reporting: CONTRACTOR will prepare and distribute copies of minutes of the meeting to each party present and to other parties who should have been present. The minutes will include a brief summary, in narrative form, of progress since the previous meeting and report.
- E. Schedule Updating: CONTRACTOR shall revise Construction Schedule after each progress meeting where revisions to Schedule have been made or recognized. Issue revised Schedule no later than 3 days after the progress meeting date to ENGINEER for distribution concurrently with the progress meeting minutes.
- F. Record Drawing: CONTRACTOR shall bring updated Record Drawing to each Progress Meeting for review.

1.09 WEEKLY PROJECT STATUS MEETINGS

- A. Weekly project status meeting shall be held.
- B. Attendees: In addition to representatives of OWNER and ENGINEER, each subcontractor currently performing work on project, and WWTP operational staff shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.

- C. This meeting shall cover schedule of work to be performed that week and to clarify coordination that must be done between project stakeholders.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 CONTRACTOR PERFORMANCE

- A. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks before proceeding to layout the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
 - 1. Record benchmark locations, with horizontal and vertical data, on Contract Record Documents.
- B. Working from lines and levels established by ENGINEER, establish benchmarks and markers to set lines and levels at each area of Work and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Do not scale Drawings to determine dimensions.
- C. Benchmarks or control points shall not be changed or relocated without prior written approval by ENGINEER. Promptly report lost or destroyed reference points, or requirements to relocate reference points because of necessary changes in grades or locations.
- D. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points.
- E. Advise entities engaged in construction activities, of marked lines and levels provided for their use.
- F. As construction proceeds, check every major element for line, level and plumb.
- G. Site Improvements: Locate and lay out site improvements, including pavements, stakes for grading, fill and topsoil placement, utility slopes, and invert elevations by instrumentation and similar appropriate means.
- H. Building Lines and Levels: Locate and lay out batter boards for structures, building foundations, column grids and locations, floor levels, and control lines and levels required for mechanical and electrical Work.
- I. Existing Utilities and Equipment:
 - 1. The existence and location of underground and other utilities and construction as shown on Drawings as existing are not guaranteed. Before beginning Site Work, CONTRACTOR shall investigate and verify the existence and location of underground utilities and other construction.
 - 2. Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction. Coordinate with local authorities having jurisdiction.
 - 3. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping.

3.02 CLEANING AND PROTECTION

- A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- C. CONTRACTOR shall provide street sweeping of site drives as directed by OWNER and ENGINEER.

3.03 PIPE LOCATIONS

- A. All pipes shall be located as indicated on the Drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

3.04 OPEN EXCAVATIONS

- A. Contractor shall adequately safeguard all open excavations by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by work people. All open excavations shall comply with applicable OSHA Standards.

3.05 TEST PITS

- A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor. Test pits shall be backfilled immediately after their purpose has been satisfied and maintained in a manner satisfactory to the Engineer. The costs for such test pits shall be borne by the Contractor.

3.06 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work on the part of the Contractor, such property shall be restored by the Contractor, at Contractor's expense, to a condition similar or equal to that existing before the damage was done, or Contractor shall make good the damage in other manner acceptable to the Engineer.

3.07 PROTECTION OF CONSTRUCTION AND EQUIPMENT

- A. All newly constructed work shall be carefully protected from damage in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions damaged shall be reconstructed by the Contractor at no additional expense to the Owner.
- B. Protect all structures in a suitable manner to prevent damage. Should any part of a structure become heaved, cracked or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor at Contractor's expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the guarantee period described in the Contract.
- C. Further, the Contractor shall take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the Owner.

3.08 MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street or driveway is received in writing from the proper authority, all excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, Contractor shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer.
- B. Detours around construction will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the Owner. All maintenance of traffic plans required for construction shall be approved by the local governmental entity having jurisdiction.
- C. The Contractor shall take precautions to prevent injury to the public and facility personnel due to open trenches. Night caretakers may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

3.09 PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside the site, except by written permission of the appropriate Owners. Contractor shall provide Owner a copy of such written permission prior to entering private land.

3.10 COOPERATION WITHIN THIS CONTRACT

- A. The Contractor shall, prior to interrupting a utility service (water, sewer, etc.) for the purpose of making cut-ins to the existing lines or for any other purposes, contact the Owner and make arrangements for the interruption, which will be satisfactory to the Owner.

3.11 COOPERATION WITH OTHER CONTRACTS

- A. This Contract may require a portion of the work to be connected to work done under other contract(s). It will be necessary for the Contractor to plan his work and cooperate with other contractors insofar as possible to prevent any interference and delay.

END OF SECTION

SECTION 01325 - CONSTRUCTION STAKING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for construction staking. All field survey efforts required for the effective prosecution of the Work, except for those items specifically identified as provided by OWNER or ENGINEER, are to be provided by CONTRACTOR.

1.02 QUALITY ASSURANCE

- A. Work described shall be performed under the direct supervision of a Professional Surveyor registered in the State of Michigan.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 CONSTRUCTION STAKEOUT

- A. CONTRACTOR is solely responsible for the means and methods of construction staking and for the adequacy and accuracy of the layout of the Work. To facilitate CONTRACTOR's construction staking, ENGINEER will provide the following field survey information:
 - 1. A point of known "line and grade" at the center of each street intersection where Work is to be performed and such other intersections as necessary for CONTRACTOR to maintain continuity of horizontal and vertical control.
 - 2. The location (shown on Drawings), and elevation of benchmarks within and contiguous to the areas where the Work is to be performed.

3.02 EXAMINATION

- A. At CONTRACTOR's option, placement of control points by ENGINEER may be scheduled as the Work progresses, but CONTRACTOR shall provide ENGINEER at least 5 days' notice prior to the need for additional control points to be provided. Alternately, all control points can be set at the beginning of the Work. CONTRACTOR is responsible for verifying layout and utility information. Once control points as described are set by ENGINEER, CONTRACTOR shall protect stakes and other markings, and replace them at CONTRACTOR's cost if they are lost or destroyed.
- B. Verify layout information shown on Drawings in relation to the property survey and existing benchmarks. Locate and protect existing benchmarks and control points, including city monuments in intersections. Preserve permanent reference points and construction stakes during construction.
- C. Confirm and make minor adjustments to the "design" as Work progresses to accommodate actual field conditions. Such confirmation and adjustment includes, but is not limited to:
 - 1. Verification of acceptable driveway grades when curb lines are laid out.

2. Resolution of conflicts between catch basin leads and water mains or other underground utilities.
- D. Such adjustments shall be reviewed with the Resident Project Representative before the Work is performed.
 - E. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning Site Work, investigate and verify the existence and location of underground utilities and other construction.
 1. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping.

3.03 PERFORMANCE

- A. Working from lines and levels established by ENGINEER, establish markers to set lines and levels at each area of Work and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Prepare "cut sheets" and other construction aids as required to accurately install the Work. Note any changes in line or grade on the Record Drawings to be delivered to ENGINEER at the completion of Project.

END OF SECTION

SECTION 01330 - SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals, including, but not necessarily limited to, the following:
 - 1. CONTRACTOR's Construction Schedule.
 - 2. Submittal Schedule.
 - 3. Shop Drawings.
 - 4. Product data.
 - 5. Samples.
 - 6. Progress photographs.
 - 7. Record photographs.

- B. Topics covered elsewhere include, but are not limited to:
 - 1. Permits.
 - 2. Applications for payment.
 - 3. Performance and payment bonds.
 - 4. Insurance certificates.
 - 5. List of subcontractors.

1.02 SUBMITTALS

- A. Bonds and Insurance Certificates shall be submitted to and approved by OWNER and ENGINEER prior to the initiation of any construction on Site.

- B. Permits, Licenses, and Certificates: For OWNER's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents; correspondence and records established in conjunction with compliance with standards; and regulations bearing upon performance of the Work.

1.03 SUBMITTAL PROCEDURES

- A. Coordination:
 - 1. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - 4. ENGINEER reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

- B. Processing:
 - 1. Allow sufficient review time so that installation shall not be delayed as a result of the time required to process submittals, including time for resubmittals. Note that products that do not

comply with AIS or other requirements of funding agency may require waivers by the US Department of Environmental Protection which may take extended time.

2. ENGINEER will review and return submittals with reasonable promptness, or advise CONTRACTOR when a submittal being processed must be delayed for coordination or receipt of additional information by putting the submittal "On Hold" and returning a transmittal identifying the reasons for the delay.
3. No extension of Contract Time will be authorized because of failure to transmit submittals to ENGINEER sufficiently in advance of the Work to permit processing.

C. Submittal Preparation:

1. Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
2. Provide a space approximately 4 inches by 5 inches on the label or beside the title block on submittals not originating from CONTRACTOR to record CONTRACTOR's review and approval markings and the action taken.
3. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of ENGINEER.
 - d. Name and address of CONTRACTOR.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
4. Any markings done by CONTRACTOR shall be done in a color other than red. Yellow and Red is reserved for ENGINEER's marking.
5. The number of copies to be submitted will be determined at the pre-construction conference. Reproducibles may be submitted and will be marked and returned to CONTRACTOR. Blue or black line prints shall be submitted in sufficient quantity for distribution to ENGINEER and OWNER recipients.
6. At completion of project, provide an electronic device that includes all submittals, O&M manuals, Construction photos, start up reports, and record drawings.

D. Submittal Transmittal:

1. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from CONTRACTOR to ENGINEER using a transmittal form. Submittals received from sources other than CONTRACTOR will be returned without action. Use separate transmittals for items from different specification sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each resubmittal (i.e., 7-A, 7-B, etc.).
2. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements. On resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.

1.04 CONSTRUCTION SCHEDULE AND COMPLIANCE TRACKING

- A. Bar Chart Schedule:
 - 1. Prepare a fully developed, horizontal bar chart type Construction Schedule. Submit within 30 days of the date established for "Notice to Proceed."
 - 2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated on Schedule of Values.
 - 3. Prepare Schedule on a sheet, or series of sheets, of stable transparency or other reproducible media, of sufficient width to show data for the entire construction period.
 - 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on Schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
 - 5. Coordinate Construction Schedule with Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 - 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on Schedule to allow time for ENGINEER's procedures necessary for certification of Substantial Completion.
- B. Compliance Tracking
 - 1. Keep continual tabulation demonstrating percentage of products complying with AIS or other contract procurement requirements.
- C. Schedule and Tracking Updating: Revise Schedule and Compliance Tracking after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

1.05 SUBMITTAL SCHEDULE

- A. After development and acceptance of Construction Schedule, prepare a complete Schedule of Submittals. Submit Schedule within 10 days of the date required for establishment of Construction Schedule.
- B. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products, as well as Construction Schedule.
- C. Prepare Schedule in chronological order; include submittals required during the first 90 days of construction. Provide the following information:
 - 1. Scheduled date for the first submittal.
 - 2. Related Section number.
 - 3. Submittal category.
 - 4. Name of subcontractor.
 - 5. Description of the part of the Work covered.
 - 6. Scheduled date for resubmittal.
 - 7. Scheduled date ENGINEER's final release or approval.
- D. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.

- E. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
- F. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

1.06 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:
 - 1. Dimensions.
 - 2. Identification of products and materials included.
 - 3. Compliance with specified standards.
 - 4. Notation of coordination requirements.
 - 5. Notation of dimensions established by field measurement.
- C. Nameplate data for equipment including electric motors shall be included on Shop Drawings. Electric motor data shall state the manufacturer, horsepower, service factor, voltage, enclosure type, oversize wiring box, etc.
- D. Shop Drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- E. Standard manufactured items in the form of catalog work sheets showing illustrated cuts of the items to be furnished, scale details, sizes, dimensions, quantity, and all other pertinent information should be submitted and approved in a similar manner.
- F. Measurements given on Shop Drawings or standard catalog sheets, as established from Contract Drawings and as approved by ENGINEER, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by CONTRACTOR. The field measurements so established shall be followed by CONTRACTOR and by all affected trades.
- G. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 36 inches by 48 inches.
- H. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.07 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.

- B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
 - 1. Manufacturer's printed recommendations.
 - 2. Compliance with recognized trade association standards.
 - 3. Compliance with recognized testing agency standards.
 - 4. Application of testing agency labels and seals.
 - 5. Notation of dimensions verified by field measurement.
 - 6. Notation of coordination requirements.
- C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed. Include within each submittal a certificate from supplier demonstrating compliance with American Iron & Steel (AIS) contract requirements. If no products are available that comply with AIS, CONTRACTOR is required to document research conducted to locate compliant products and wait for waiver decision from US Environmental Protection Agency.

1.08 SAMPLES

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
- B. Mount, display, or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match ENGINEER's Sample. Include the following:
 - 1. Generic description of the Sample.
 - 2. Sample source.
 - 3. Product name or name of manufacturer.
 - 4. Compliance with recognized standards.
 - 5. Availability and delivery time.
- C. Submit Samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- D. Where variation in color, pattern, texture, or other characteristics are inherent in the material or product represented, submit multiple units (not less than 3) that show approximate limits of the variations.
- E. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
- F. Preliminary Submittals: Where Samples are for selection of color, pattern, texture, or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
 - 1. Preliminary submittals will be reviewed and returned with ENGINEER's mark indicating selection and other action.
- G. Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit 3 sets; 1 will be returned marked with the action taken.

- H. Maintain sets of Samples, as returned, at the Site, for quality comparisons throughout the course of construction.
- I. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
- J. Sample sets may be used to obtain final acceptance of the construction associated with each set.

1.09 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, ENGINEER will review each submittal, mark to indicate action taken, and return promptly.
 - 1. Compliance with specified characteristics is CONTRACTOR's responsibility.
- B. Action Stamp: ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 - 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
 - 2. Final-But-Restricted Release: When submittals are marked "Furnish as Corrected," that part of the Work covered by the submittal may proceed, provided it complies with notation or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 - 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - a. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at Site, or elsewhere where Work is in progress.
 - 4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Acknowledge Receipt."
 - 5. The approval of ENGINEER shall not relieve CONTRACTOR of responsibility for errors on Drawings or submittals as ENGINEER's checking is intended to cover compliance with Drawings and Specifications and not enter into every detail of the shop work.

1.10 PROGRESS PHOTOGRAPHS

- A. During the process of the Work, photographs shall be taken at the rate of at least 100 every month from start of construction until acceptance by OWNER. These photographs shall be taken from points and at the times directed by ENGINEER.
- B. Digital files in high resolution JPEG format and of adequate quality to reproduce prints of approximately 7-1/2 x 9-1/2 inches overall, shall be provided to ENGINEER and OWNER. However, the requirement for numbers of prints and binding shall remain unchanged. At the conclusion of the Work, the digital files shall become the property of the OWNER.
- C. Upon completion of the Work the digital photos shall be copied to two electronic devices and shall be turned over to the OWNER.

1.11 RECORD PHOTOGRAPHS

- A. After final acceptance of the Work, 24 photographs shall be taken of each structure and major feature of the Project as directed by ENGINEER. These photographs shall be taken from points and at times directed by ENGINEER.
- B. Two electronic devices containing all record photos shall be turned over to the OWNER at the completion of the Work.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01420 - DEFINITIONS AND STANDARDS

PART 1 - GENERAL

1.01 DEFINITIONS

- A. Basic Contract definitions are included in the General Conditions.
- B. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.02 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards CONTRACTOR must keep available at Site for reference.
- B. Updated Standards: At the request of ENGINEER, CONTRACTOR, or authority having jurisdiction, submit a Change Order proposal where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected. ENGINEER will decide whether to issue a Change Order to proceed with the updated standard.
- C. Minimum Quantity or Quality Levels: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to ENGINEER for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed for performance of a required construction activity, CONTRACTOR shall obtain copies directly from the publication source.
- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be, but are not assured to be, accurate and up to date as of date of Contract Documents.

AASHTO American Association of State Highway and
Transportation Officials
444 North Capitol St., NW, Suite 249; Washington, D.C. 20001

ACI American Concrete Institute
P.O. Box 9094; Farmington Hills, MI 48333-9094

ACPA American Concrete Pipe Association
222 West Las Colinas Blvd., Suite 641; Irving, TX 75039-5423

AFBMA Anti-Friction Bearing Manufacturing Association

AFPA American Forest & Paper Association
1111 19th St., NW, Suite 800; Washington, D.C. 20036

AGA American Gas Association
400 N Capitol St., NW; Washington, D.C. 20001

AGMA American Gear Manufacturers Association

AI Asphalt Institute
Research Park Dr., P.O. Box 14052; Lexington, KY 40512-4052

A.I.A. American Insurance Association
1130 Connecticut Ave., NW, Suite 1000; Washington, D.C. 20036

AISC American Institute of Steel Construction
One East Wacker Dr., Suite 3100; Chicago, IL 60601-2001

AISI American Iron and Steel Institute
1101 Seventeenth St., NW; Washington, D.C. 20036

AITC American Institute of Timber Construction
7012 S. Revere Parkway, Suite 140; Englewood, CO 80112

ALI Associated Laboratories, Inc.
P.O. Box 152837; Dallas, TX 75315

ALSC American Lumber Standard Committee
P.O. Box 210; Germantown, MD 20875-0210

AMCA Air Movement and Control Association
30 W. University Dr.; Arlington Heights, IL 60004-1893

ANSI American National Standards Institute
25 West 43rd St.; New York, NY 10036

API American Petroleum Institute
1220 L St., NW; Washington, D.C. 20005-4070

AREA American Railway Engineering Association
50 F Street, NW, Suite 7702, Washington, D.C. 20001

ASCE American Society of Civil Engineers
1801 Alexander Bell Dr.; Reston, VA 20191-4400

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, NE; Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th St.; New York, NY 10017
ASSE	American Society of Safety Engineers 1800 East Oakton Street, Des Plaines, IL 60018
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr.; West Conshohocken, PA 19428-2959
AWPA	American Wood-Preservers' Association P.O. Box 5690; Granbury, TX 76049
AWS	American Welding Society 550 NW Le Jeune Rd.; Miami, FL 33126
AWWA	American Water Works Association 6666 W. Quincy Ave.; Denver, CO 80235
CISPI	Cast Iron Soil Pipe Institute 1499 Chain Bridge Rd.; Suite 203; McLean, VA 22101
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Rd.; Schaumburg, IL 60173
CSA	Canadian Standards Association
FM	Factory Mutual Engineering and Research 1151 Boston-Providence Turnpike; Norwood, MA 02062-9102
H.I.	Hydraulic Institute 9 Sylvan Way; Parsippany, NJ 07054
IEEE	Institute of Electrical and Electronic Engineers 3 Park Ave., 17 th Floor; New York, NY 10016-5997
IPCEA	Insulated Power Cable Engineers Association
ISA	Instrument Society of America 67 Alexander Dr.; Research Triangle Park, NC 27709
MBMA	Metal Building Manufacturers Association 1300 Summer Ave.; Cleveland, OH 44115-2851
NAPA	National Asphalt Pavement Association 5100 Forbes Blvd.; Lanham, MD 20706-4413

NCPI	National Clay Pipe Institute P.O. Box 759; Lake Geneva, WI 53147
NEC	National Electrical Code (by NFPA)
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association 1300 North 17 th St., Suite 1847; Rosslyn, VA 22209
NFPA	National Fire Protection Association 1 Batterymarch Park; Quincy, MA 02269-9101
NPCA	National Precast Concrete Association 10333 North Meridian St., Suite 272; Indianapolis, IN 46290
PCA	Portland Cement Association 5420 Old Orchard Rd.; Skokie, IL 60077-1083
PCI	Precast/Prestressed Concrete Institute 209 W. Jackson Blvd.; Chicago, IL 60606-6938
PDI	Plumbing and Drainage Institute 800 Turnpike Street, Suite 300, North Andover, MA 01845
PTI	Post-Tensioning Institute 1717 W. Northern Ave., Suite 114; Phoenix, AZ 85021
RIS	Redwood Inspection Service 405 Enfente Dr., Suite 200; Novato, CA 94949
SAE	Society of Automotive Engineers 400 Commonwealth Dr.; Warrendale, PA 15096-0001
SDI	Steel Deck Institute P.O. Box 25; Fox River Grove, IL 60021-0025
SJI	Steel Joist Institute 3127 10 th Ave. North Ext.; Myrtle Beach, SC 29577-6760
SMACNA	Sheet Metal & Air Conditioning Contractors' National Association 4201 Lafayette Center Dr.; Chantilly, VA 20151-1209
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway; Pensacola, FL 32504-9094
SSPC	The Society for Protective Coatings 40 24 th St., 6 th Floor; Pittsburgh, PA 15222-4565

TPI Truss Plate Institute
583 Donofrio Dr., Suite 200; Madison, WI 53719

UL Underwriters Laboratories
333 Pfingsten Rd.; Northbrook, IL 60062-2096

WCLIB West Coast Lumber Inspection Bureau
P.O. Box 23145; Portland, OR 97281

WWPA Western Wood Products Association
522 SW Fifth Ave., Suite 500; Portland, OR 97204-2122

F. Government Agencies. Names and titles of state and Federal Government standard or Specification producing agencies are frequently abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or Specification producing agencies of the Federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

CE Corps of Engineers
(U.S. Department of the Army)
Chief of Engineers - Referral
Washington, D.C. 20314

CFR Code of Federal Regulations
(Available from the Government Printing Office)
N. Capitol Street between G and H St. NW
Washington, D.C. 20402
(Material is usually first published in the Federal Register)

DOT Department of Transportation
400 Seventh Street, SW
Washington, D.C. 20590

EDA Economic Development Administration
U.S. Department of Commerce
121 N. Canal Street, Suite 855
Chicago, IL 60606

EPA Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

MEGLE Michigan Department of Environment, Great Lakes and Energy

MDOT Michigan Department of Transportation

MIOSHA State of Michigan OSHA

OSHA Occupational Safety and Health Administration
(U.S. Department of Labor)
Government Printing Office
Washington, D.C. 20402

1.03 GOVERNING REGULATIONS/AUTHORITIES

- A. ENGINEER has contacted authorities having jurisdiction where necessary to obtain information necessary for the preparation of Contract Documents; that information may or may not be of significance to CONTRACTOR. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.

1.04 SUBMITTALS

- A. Permits, Licenses, and Certificates: For OWNER's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01450 - QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for quality control services.
- B. Quality control services include inspections and tests and related actions including reports, performed by independent agencies, governing authorities, and CONTRACTOR. They do not include Contract enforcement activities performed by ENGINEER.
- C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve CONTRACTOR of responsibility for compliance with Contract Document requirements.
- D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
- E. Specific quality control requirements for individual construction activities are specified in the Sections that specify those activities. Those requirements, including inspections and tests, cover production of standard products as well as customized fabrication and installation procedures.
- F. Inspections, tests, and related actions specified are not intended to limit CONTRACTOR's quality control procedures that facilitate compliance with Contract Document requirements.
- G. Requirements for CONTRACTOR to provide quality control services required by ENGINEER, OWNER, or authorities having jurisdiction are not limited by provisions of this Section.

1.02 CONTRACTOR RESPONSIBILITIES

- A. Provide inspections, tests, and similar quality control services, specified in individual Specification Sections and required by governing authorities, except where they are specifically indicated to be OWNER's responsibility, or are provided by another identified entity; these services include those specified to be performed by an independent agency and not by CONTRACTOR. Costs for these services shall be included in the Contract Price.
- B. Employ and pay an independent agency to perform specified quality control services.
- C. CONTRACTOR and each agency engaged to perform inspections, tests, and similar services shall coordinate the sequence of activities to accommodate required services with a minimum of delay. In addition, CONTRACTOR and each agency shall coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
- D. Schedule times for inspections, tests, taking samples, and similar activities.
- E. Retesting: CONTRACTOR is responsible for retesting where results of required inspections, tests, or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was CONTRACTOR's responsibility.

1. Cost of retesting construction revised or replaced by CONTRACTOR is CONTRACTOR's responsibility, where required tests were performed on original construction.
- F. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include but are not limited to:
1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests.
 2. Taking adequate quantities of representative samples of materials that require testing or assisting the agency in taking samples.
 3. Providing facilities for storage and curing of test samples, and delivery of samples to testing laboratories.
 4. Providing the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
 5. Security and protection of samples and test equipment at the Project site.

1.03 OWNER RESPONSIBILITIES

- A. Provide inspections, tests, and similar quality control services specified to be performed by independent agencies and not by CONTRACTOR, except where they are specifically indicated as CONTRACTOR's responsibility or are provided by another identified entity. Costs for these services are not included in the Contract Price.
- B. Engage and pay for the services of an independent agency to perform inspections and tests specified as OWNER's responsibility.
- C. OWNER will employ and pay for the services of an independent agency, testing laboratory, or other qualified firm to perform services which are OWNER's responsibility.

1.04 TESTING AGENCY RESPONSIBILITIES

- A. Where OWNER has engaged a testing agency or other entity for testing and inspection of a part of the Work, and CONTRACTOR is also required to engage an entity for the same or related element, CONTRACTOR shall not employ the entity engaged by OWNER, unless otherwise agreed in writing with OWNER.
- B. The independent testing agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Specification Sections shall cooperate with ENGINEER and CONTRACTOR in performance of its duties, and shall provide qualified personnel to perform required inspections and tests.
- C. The agency shall notify ENGINEER and CONTRACTOR promptly of irregularities or deficiencies observed in the Work during performance of its services.
- D. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents, or approve or accept any portion of the Work.
- E. The agency shall not perform any duties of CONTRACTOR.

1.05 SUBMITTALS

- A. The independent testing agency shall submit a certified written report of each inspection, test, or similar service to ENGINEER in triplicate, unless CONTRACTOR is responsible for the service. If CONTRACTOR is responsible for the service, submit a certified written report of each inspection, test, or similar service through CONTRACTOR in triplicate.
- B. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
- C. Written reports of each inspection, test, or similar service shall include, but not be limited to:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making the inspection or test.
 - 6. Designation of the Work and test method.
 - 7. Identification of product and Specification Section.
 - 8. Complete inspection or test data.
 - 9. Test results and an interpretation of test results.
 - 10. Ambient conditions at the time of sample taking and testing.
 - 11. Comments or professional opinion as to whether inspected or tested Work complies with Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

- A. Upon completion of inspection, testing, sample taking, and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes.
- B. Protect construction exposed by or for quality control service activities and protect repaired construction.
- C. Repair and protection are CONTRACTOR's responsibility regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION

SECTION 01500 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: This Section specifies procedural and administrative requirements for temporary services and facilities.
- B. Temporary Utilities include, but are not limited to:
 - 1. Water service and distribution.
 - 2. Temporary electric power.
 - 3. Temporary lighting.
 - 4. Telephone service.
 - 5. Public and private utilities coordination.
 - 6. Storm and sanitary sewer.
- C. Temporary Construction and Support Facilities include, but are not limited to:
 - 1. Temporary heating facilities.
 - 2. CONTRACTOR's field offices and storage sheds.
 - 3. ENGINEER's field office.
 - 4. Temporary roads and paving.
 - 5. Sanitary facilities.
 - 6. Dewatering facilities and drains.
- D. Construction Buildings and Facilities include, but are not limited to.
 - 1. Temporary enclosures.
 - 2. Temporary Project identification signs.
 - 3. Temporary Site identification signs.
 - 4. Temporary Project bulletin boards.
 - 5. Stairs.
 - 6. Hoists.
 - 7. Temporary elevator use.
 - 8. Ongoing construction cleanup.
 - 9. Rodent and pest control.
 - 10. Storage of equipment and material.
- E. Security and Protection Facilities required include, but are not limited to:
 - 1. Temporary fire protection.
 - 2. Permanent fire protection.
 - 3. Barricades, warning signs, lights.
 - 4. Enclosure fence for the Site.
 - 5. Private Owner fences.
 - 6. Security enclosure and lockup.
 - 7. Environmental protection.
 - 8. Control of noise.
 - 9. On-site burning.
 - 10. Dust control.

- F. Sedimentation Control Facilities required include, but are not limited to:
 - 1. Soil erosion and sedimentation control.
 - 2. Stormwater discharge control.
 - 3. Dewatering trenches and disposal of excess excavated material.
 - 4. Stream bank protection.
 - 5. Slope protection - adjacent to stream crossings.
 - 6. Slope protection.
 - 7. Final topography protection.

1.02 REFERENCES

- A. Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994.
- B. Guidebook of Best Management Practices for Michigan Watersheds.
- C. Local Soil Erosion Control Ordinance or requirements.
- D. Michigan Manual of Uniform Traffic Control Devices (MMUTCD).
- E. Codes and Standards:
 - 1. Comply with NFPA Code 241, "Building Construction and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library, "Temporary Electrical Facilities."
 - 2. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services," prepared jointly by AGC and ASC, for industry recommendations.
 - 3. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. CONTRACTOR shall submit the Plan of Action for Traffic Control in 6 copies within 10 days after the Notice to Proceed is issued. CONTRACTOR shall not commence Work on any State trunk line or major artery without written approval of the Plan for that portion of the Contract.
 - 2. Soil Erosion and Sedimentation Control Program prepared by CONTRACTOR, as specified in this Section, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the Pre-Construction Conference, at which time final revisions may be made. Copies of the final agreed program, and Act 451 Permit, shall be delivered to ENGINEER a minimum of 2 weeks prior to beginning any Work on Site.
 - 3. Temporary Utilities: Submit a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to OWNER, change over from use of temporary service to use of the permanent service.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to:
 - 1. Building Code requirements.
 - 2. Health and Safety regulations.

3. Utility Company regulations.
4. Police, Fire Department, and Rescue Squad rules.
5. Environmental Protection regulations.
6. State and Local Soil Erosion and Sedimentation Control regulations.

B. Inspection: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.05 PROJECT CONDITIONS

- A. Unless otherwise provided in these Specifications, CONTRACTOR shall make CONTRACTOR's own arrangements for electricity, gas, water, and sewer services for use during the construction of the Work and shall pay for all temporary facilities, connections, extensions, and services.
 1. Cost or use charges for temporary facilities are not chargeable to OWNER or ENGINEER, and will not be accepted as a basis of claims for a Change Order.
- B. Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities or permit them to interfere with progress. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on Site.
- C. Special Requirements: Special requirements of OWNER and MDOT being specified for traffic control on State trunk lines and major arteries due to the magnitude of traffic disruption involved in this Contract.

1.06 SEQUENCING AND SCHEDULING

- A. CONTRACTOR shall inform the local Fire Department in advance of CONTRACTOR's program of street obstruction and detours, so that the Fire Department can set up plans for servicing the area in case of an emergency.
 1. CONTRACTOR shall also notify the public agency having jurisdiction over the roads at least 1 week prior to obstructing any street.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide new materials; if acceptable to ENGINEER, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Water: Provide potable water approved by local health authorities.
- C. Open-Mesh Fencing: Provide 11-gauge, galvanized 2-inch, chain-link fabric fencing 6 feet high with galvanized barbed wire top strand and galvanized steel pipe posts, 1-1/2-inch inside diameter for line posts and 2-1/2-inch inside diameter for corner posts.
- D. Seed: Consisting of, per acre, 10 pounds Kentucky 31 fescue, 3 pounds Birdsfoot Trefoil, and 3 pounds white clover.
- E. Fertilizers: Consisting of, at least, 200 pounds per acre 12:12:12, or equivalent.

- F. Mulches: Consisting of 2 tons per acre of straw or hay. Chemical mulch or other approved material may be used.
- G. Sod: Shall be as specified in Division 2.

2.02 EQUIPMENT

- A. Provide new equipment; if acceptable to ENGINEER, undamaged, previously used equipment in serviceable condition may be used. Provide equipment suitable for use intended.
- B. Electrical Outlets: Provide properly configured NEMA polarized outlets to prevent insertion of 110 to 120 volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- C. Electrical Power Cords: Provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.
- D. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- E. Temporary Offices: Provide prefabricated or mobile units or similar on-site construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air conditioned units on foundations adequate for normal loading.
- F. Temporary Toilet Units: Provide self-contained single-occupant toilet units, properly vented and fully enclosed with a glass fiber-reinforced polyester shell or similar nonabsorbent material.
- G. First Aid Supplies: Comply with governing regulations.
- H. Fire Extinguishers: Provide hand-carried, portable, UL rated, Class "A" fire extinguishers for temporary offices and similar spaces.
 - 1. In other locations, provide hand-carried, portable, UL rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
 - 2. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.
- I. Project Identification Signs: Provide 8-foot wide by 4-foot high Project sign as detailed, of solid cedar wood and MDO plywood, painted, with exhibit lettering by a professional sign painter, with final graphics as approved by ENGINEER.
- J. Bulletin Board: Provide a weather-protected enclosed bulletin board at Site. The bulletin board shall be mounted in a conspicuous and public outside location.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they shall serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed, or are replaced by authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION

- A. Engage the appropriate local utility company to install temporary service or to connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
 - 1. Arrange with the company and existing users for a time when service can be interrupted, where necessary, to make connections for temporary services.
- B. Water Service and Distribution: CONTRACTOR shall at all times provide for CONTRACTOR's employees an abundant and convenient supply of cool drinking water taken from a potable source.
- C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground fault interrupters, and main distribution switchgear.
 - 1. Except where overhead service must be used, install electric power service underground.
 - 2. Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
- D. Temporary Lighting: Wherever overhead floor or roof deck has been installed, provide temporary lighting with local switching.
 - 1. Install and operate temporary lighting that shall fulfill security and protection requirements, without operating the entire system, and shall provide adequate illumination for construction operations and traffic conditions.
 - 2. When permanent lights and receptacles are installed in new areas of construction, CONTRACTOR may use them, provided CONTRACTOR reimburses OWNER for the energy consumed under the following conditions:
 - a. If the new lights and receptacles are placed on an extension of an existing distribution system, CONTRACTOR shall pay a prorated amount agreed to with OWNER if no meter exists to determine actual energy consumption.
 - b. If the new lights and receptacles are on a new service, CONTRACTOR shall pay the entire bill (which includes transformer losses, power factor penalties, minimum demand charges, energy adjustments, etc.) as metered on the new service. A new service is a plant connection provided under this Contract that will increase OWNER's electrical costs.
 - 3. CONTRACTOR shall investigate the billing structure before requesting the new service to be energized for facility construction purposes. Once energized, the service shall remain energized. Where a new service is required to provide test power to equipment for performance tests, power will not be paid for by OWNER until construction is 90 percent complete as determined

by the payment certificates. Any costs associated with CONTRACTOR requests for power prior to the 90 percent construction completion will be paid for by CONTRACTOR. In no case shall OWNER begin paying the entire electrical bill until OWNER has beneficial use of the facilities.

- E. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period. Install telephone on a separate line for each temporary office and first aid station.
 - 1. At each telephone, post a list of important telephone numbers.

- F. Public and Private Utilities: Where any utilities, water, sewer, gas, telephone, or any other either public or private, are encountered, CONTRACTOR must provide adequate protection for them, and CONTRACTOR shall be held responsible for any damages to such utilities arising from CONTRACTOR's operations.
 - 1. When it is apparent that construction operations may endanger the foundation of any utility conduit or the support of any structure, CONTRACTOR shall notify the utility Owner of this possibility and CONTRACTOR shall take such steps as may be required to provide temporary bracing or support of conduits or structures.
 - 2. Where it is the policy of utility Owners to make repairs to damaged conduit or other structures, CONTRACTOR shall cooperate to the fullest extent with the utility, and CONTRACTOR shall see that CONTRACTOR's operations interfere as little as possible with those operations.
 - 3. When it is necessary to carry out the Work, that an electric, telephone, or light pole be moved to a new location, or moved and replaced after construction, CONTRACTOR shall arrange for the moving of such poles and the lines thereof, and shall pay any charges therefor.
 - 4. Where existing utilities are encountered along the line of Work, CONTRACTOR shall perform CONTRACTOR's operations in such a manner that service will not be interrupted, and shall, at CONTRACTOR's own expense, make all temporary provisions to maintain service.
 - 5. Unless otherwise indicated on Drawings, CONTRACTOR shall replace any disturbed sewer or drain, or relay same at a new grade to be established by ENGINEER, such that sufficient clearance for the sewer will be provided.
 - 6. CONTRACTOR will receive no extra compensation for replacement of sewers or drains encountered, or for relaying at a new grade and/or line where necessary, except where specifically noted otherwise on Drawings or Specifications.
 - 7. Where existing gas mains and services are encountered, CONTRACTOR shall arrange with the gas company for any necessary relaying, and shall pay for the cost of such work.
 - 8. Materials used in repairing or relaying utilities shall be the same type and strength as the existing Work.

- G. Storm and Sanitary Sewers: If sewers are available, CONTRACTOR may provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide portable units.
 - 1. If gas is present in existing sewers or tanks where CONTRACTOR must work, they shall be cleared of gas before entering. If the gas cannot be removed by natural ventilation by the removal of covers, CONTRACTOR shall maintain forced draft to render the area safe as determined by gas detection equipment.
 - 2. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
 - 3. Connect temporary sewers to the municipal system as directed by the sewer department officials.
 - 4. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Following heavy use, restore normal conditions promptly.

5. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains.

3.03 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

- A. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 1. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to OWNER.
 2. Provide incombustible construction for offices, shops, and sheds located within the construction area, or within 30 feet of building lines. Comply with requirements of NFPA 241.
- B. Temporary Heating Facilities: Provide temporary heat required by construction activities for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
 1. Except where use of the permanent system is authorized, provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control.
 2. Use of gasoline-burning space heaters, open flame, or salamander-type heating units is prohibited.
- C. CONTRACTOR's Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at Site. Keep the office clean and orderly for use for small progress meetings.
- D. ENGINEER's Field Office: Before the construction Work is laid out or started, an office for OWNER's Resident Project Representative shall be provided by CONTRACTOR at a point on the Site to be designated.
 1. This office shall be a minimum of 10 feet by 60 feet in plan. Two doors, 2 single windows, and a double window shall be provided. The doors shall be equipped with a cylinder lock. The office shall be equipped using acceptable second-hand or on-site constructed furniture as follows:
 - a. Three plan racks and four-drawer cabinets.
 - b. Drawing table and stool.
 - c. Three desks with drawers.
 - d. Three desk chairs.
 - e. Instrument rack.
 - f. Six electric convenience outlets.
 - g. Three wastebaskets.
 - h. Two plan (reference) tables and stools.
 - i. Two smoke alarms.
 - j. Two 10-pound fire extinguishers for Class "ABC" fires.
 2. ENGINEER's field office shall be for the exclusive use of ENGINEER and shall be securely anchored for stability in high winds.
 3. CONTRACTOR shall provide electric or propane heat, electric air conditioning, screened and locking windows, toilet and lavatory facilities with potable water, wardrobe closet, electric light, local phone service with two phone lines, and semi-weekly janitorial service in ENGINEER's office during the continuance of this Contract. Offices shall have a minimum of 6'-9" ceiling height.

4. Four parking spaces close to ENGINEER's office shall be provided and reserved for ENGINEER.
 5. CONTRACTOR shall arrange, furnish and provide service for during the Contract Times:
 - a. DSL service.
- E. Temporary Roads and Paving: Construct and maintain temporary roads and paving to adequately support the indicated loading and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with ENGINEER.
1. Comply with Section 02740 for construction and maintenance of temporary asphalt concrete paving.
 2. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.
 3. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas that are without damage or deterioration when occupied by OWNER.
 4. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.
 5. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.
- F. Sanitary Facilities: Sanitary facilities include temporary toilets, wash facilities, and drinking water fixtures. Comply with regulations and health Codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best service the Project's needs.
1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
 2. Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
 3. Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
 4. Provide safety showers, eyewash fountains and similar facilities where needed for safety and sanitation of personnel.
- G. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the Site, excavations, and construction free of water.

3.04 CONSTRUCTION BUILDINGS AND FACILITIES INSTALLATION

- A. Storage platforms, sheds, temporary closures for doors, windows and other openings of buildings, temporary sidewalks, runways, and ladders shall be provided.
1. Hazardous areas shall be protected by guardrails and fences. Storage platforms and sheds shall be provided for materials which require protection from the weather.
 2. Sheds shall be substantially constructed and covered with "ready roofing." Doors, windows, and other openings in the permanent work shall be closed as soon as necessary to safeguard the construction and materials from tampering or damage.

3. Enclosures for openings easily accessible from the exterior shall be of solid wood or sash, provided with necessary hardware and padlocks. Other openings shall be enclosed by old sash or canvas on wooden frames for the protection of the building against damage by weather.
 4. Enclosures shall be weathertight and secured in such manner as not to damage the finish of the building.
- B. Temporary Enclosures: Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.
1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.
 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.
- C. Temporary Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated. Verify with ENGINEER final wording of graphics to be placed on sign and final location of sign. Obtain sign permit from local authority.
- D. Temporary Site Identification and Signs: Prepare Site identification and other signs of the size indicated; install signs where indicated or as directed by ENGINEER to inform construction personnel, public and visitors seeking entrance to Site. Do not permit installation of unauthorized signs.
- E. Temporary Project Bulletin Board: As a minimum, the following items must be posted:
1. Wage Rates (when applicable).
 2. Safety Poster (OSHA or State OSHA).
 3. Nondiscrimination Poster.
 4. Equal Employment Opportunity Statement signed by a Company official.
 5. Grading Permit (Soil Erosion and Sedimentation Control Act 451).
- F. Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished permanent stairs with a protective covering of plywood or similar material so finishes will be undamaged at the time of acceptance.
- G. Hoists: CONTRACTOR shall provide temporary hoists to lift building materials and equipment to the intended areas. Hoists shall be capable of carrying the intended load without exceeding the load limitation of the hoisting device.
- H. Ongoing Construction Cleanup: Project cleanup shall be an ongoing operation. CONTRACTOR shall maintain an order of neatness and good housekeeping comparable to that maintained by OWNER. Project cleanup applies to the Site and all areas affected by construction operations. CONTRACTOR shall:
1. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

2. Maintain dirt and debris resulting from CONTRACTOR's operations in designated spoil piles as approved by ENGINEER or remove from the Site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations. Excess dirt and debris shall be removed from the Site as needed to confine spoil piles in designated areas.
 3. Perform general cleanup inside of OWNER's buildings at least once every two weeks. Cleanup shall include consolidation of stored materials, removal of waste material and debris, and sweeping of flooring surfaces.
 4. Maintain clear access to all properties affected by construction activities. Maintain unobstructed access to existing buildings, equipment, safety equipment, and other items requiring OWNER access for facility operation.
 5. Keep tools, equipment, and materials in a neat and orderly arrangement.
 6. Maintain culverts, sewers, and drainage structures by removing sediment and debris from construction operations.
 7. Repair all holes and ruts resulting from construction operations that affect OWNER's use of property with approved material; compact, level, and restore.
- I. Rodent and Pest Control: CONTRACTOR shall employ a licensed pest control service during the Contract Times of this Contract.
1. Pest control service shall maintain Site free from:
 - a. Mice, rats, and similar rodents.
 - b. Termites, carpenter ants, and similar pests.
 2. Pest control services shall be performed at the start of the Project. Inspections and maintenance of pest control products shall be performed on a monthly basis.
- J. Storage of Equipment and Material: Pumps and other machinery units shall be stored in weathertight structures provided by CONTRACTOR.
1. Motors, electrical switchgear, gauges, and other equipment of a delicate nature, as determined by ENGINEER, shall be stored in weathertight warehouses which are maintained at a temperature of at least 60 degrees F.
 2. Structural steel, miscellaneous and cast iron items may be placed in open yard storage, but any such items having attached motors or other machinery units shall have such units well wrapped with waterproof paper or cloth for protection from the weather.
 3. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of ENGINEER.
 4. Materials and equipment distributed, stored, and placed upon or near the Site of the Work shall at all times be so disposed as not to interfere with work prosecuted by OWNER or other Contractors in the employment of OWNER or with drainage. Materials and equipment shall not be stored on public streets.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer as requested by ENGINEER.
- B. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10, "Standard for Portable Fire Extinguishers," and NFPA 241, "Standard for Safeguarding Construction, Alterations and Demolition Operations."

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than 1 extinguisher on each floor at or near each usable stairwell.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
 4. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
- C. Barricades, Warning Signs, and Lights: Comply with Standards and Code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
- D. Enclosure Fence for the Site: When excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire Site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the Site, except by the entrance gates.
1. Provide open-mesh, chain-link fencing with posts set in a compacted mixture of gravel and earth.
- E. Private Owner Fences: No fences shall be removed or destroyed by CONTRACTOR without the written permission of ENGINEER. CONTRACTOR shall be held fully responsible for any damages caused by CONTRACTOR's work to adjoining fences. Fences that have to be removed shall be preserved and replaced in a manner acceptable to ENGINEER. Damaged material shall be replaced by new material.
- F. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
1. Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- G. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the Site.
- H. Control of Noise: CONTRACTOR shall eliminate noise to as great an extent as possible at all times. Air compressors shall be equipped with silencers, and the exhaust of all gasoline motors and other power equipment shall be provided with mufflers.
1. In the vicinity of hospitals, libraries, and schools, special precautions shall be taken to avoid noise and other nuisance, and CONTRACTOR shall require strict observances of all pertinent ordinances and regulations. Any blasting permitted in such locations shall be done with reduced charges.

- I. On-Site Burning: Burning of waste materials resulting from the Work under this Contract will not be allowed unless authorized in writing by OWNER. Where burning is not allowed, CONTRACTOR shall haul all waste materials from Site and dispose of same in a manner acceptable to ENGINEER.
 1. The costs of hauling and disposal of waste materials shall be included in other items of the Work under this Contract.
- J. Dust Control: CONTRACTOR shall take all steps necessary for the alleviation or prevention of dust nuisance caused by or resulting from CONTRACTOR's operations and shall apply water or dust palliative, or both, as required. No direct payment will be made for any such Work performed or materials used to control dust from this Contract.

3.06 SEDIMENTATION CONTROL FACILITIES INSTALLATION

- A. Soil Erosion and Sedimentation Control: CONTRACTOR shall take all precautions necessary to prevent soil erosion of areas disturbed by the construction and shall ensure that all soil erosion be contained within the construction Site. CONTRACTOR shall provide temporary slope protection, temporary dikes, etc., as required to prevent eroded materials from entering any sewers or natural watercourses.
 1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 91 of the Michigan Compiled Laws and local city or county soil erosion control programs.
 2. CONTRACTOR shall prepare a Soil Erosion and Sedimentation Control Program for submittal to and approval by Local Soil Erosion and Sedimentation Control Agent prior to start of construction, as required in the following paragraphs. Copies of State guidelines "Better Environment through Soil Erosion and Sedimentation Control" and "Protection of Natural Resources" DEQ Handbook of Specifications may be obtained at no charge from the Michigan Department of Environmental Quality (MDEQ). The "Michigan Soil Erosion and Sedimentation Control Guidebook" and the "Guidebook of Best Management Practices for Michigan Watersheds" may also be obtained from MDEQ.
 3. Since it is impractical to identify specific potential soil erosion problems along a water main route, CONTRACTOR, after award but prior to the Pre-Construction Conference, together with the local soil erosion Enforcing Agent, shall identify all potential soil erosion problem areas and prepare a detailed Soil Erosion and Sedimentation Control Program satisfying CONTRACTOR's specific method of operation. This program shall include as a minimum, but not necessarily be limited to, the following:
 - a. Identify on a separate set of Drawings all soil erosion problem areas.
 - b. Identify specific control structure using DEQ United Keying System from the "Michigan Soil Erosion and Sedimentation Control Guidebook" to be placed to control erosion and to prevent soil from entering storm sewers and streams.
 - c. Indicate timing of placement and removal of structures both in relationship to time of year and to sequence of construction.
 - d. Indicate timing of completion of cleanup and surface restoration after control structures are removed.
 4. The Soil Erosion and Sedimentation Control Program, prepared by CONTRACTOR, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the Pre-Construction Conference, at which time final revisions may be made. Copies of the final agreed program shall be made available for ENGINEER and the local Enforcing Agent. Should the local regulatory agency determine at any time during construction that the construction operation is in violation of the Act and cite OWNER, CONTRACTOR or subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.

- B. Stormwater Discharge Control:
1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 31 of the Michigan Compiled Laws and local city or county stormwater discharge control programs.
 2. CONTRACTOR shall not begin any Work at Site until the stormwater discharge permit has been obtained for the Project.
 - a. CONTRACTOR shall indemnify OWNER against any and all fines for discharge permit violations which are assessed against OWNER, and which are due to CONTRACTOR's actions or failure to maintain the sedimentation control measures.
 3. CONTRACTOR shall utilize the appropriate Best Management Practices to prevent any of CONTRACTOR's activities from resulting in an unlawful discharge of pollutants to the waters of the State. CONTRACTOR shall correct any deficiencies noted by ENGINEER, Local Enforcement Agency or MDEQ within 24 hours of receiving written notice that corrections are necessary. Should CONTRACTOR fail to take action within the allotted time, OWNER shall have the right to perform the work and deduct all costs from amounts due CONTRACTOR under this Contract.
- C. Dewatering Trenches and Disposal of Excess Excavated Material:
1. Pumping or draining from trench excavations shall be made on either side of the pipeline and not into the waters of the State. It shall be CONTRACTOR's responsibility to secure the necessary approval of private landowners before discharging water from the trench excavation onto private lands. Water shall be discharged in such a manner as to cause no pollution or erosion problems.
 2. CONTRACTOR shall dewater to existing storm sewer systems wherever possible; method of disposal shall be approved by OWNER. All discharge from dewatering wells discharged onto the ground ahead of being piped to a natural watercourse or lake via an existing storm sewer system or by a temporary piping system shall have built at the point of entry into such storm sewer a silt retention structure.
 3. The silt retention structure may consist of several straw bales adequately anchored and placed as directed by ENGINEER. Any eventual silt or solids retained in the area of these structures shall be removed prior to removal of the structure. At no time will silt or similar materials be permitted to filter into a lake or natural watercourse. There shall be no sidcasting of any excavated material into any waterway. Excess excavated material from stream crossings and excavation near streams shall be removed and disposed of elsewhere, and not within the floodplain.
- D. Stream Bank Protection: The banks of streams shall not be left unprotected for more than 1 day where possible, but never more than 7 days after the stream crossing is completed. Replacing of bank plug and grading of stream banks within 50 feet of the stream shall be accomplished immediately following pipe laying. Construction will not be allowed to continue at the expense of not providing stream bank protection.
1. All disturbed stream banks shall be finished with a slope not steeper than 2:1 (2 horizontal to 1 vertical). The 2:1 slope shall be graded up and back to the high water line. If the top of the natural bank is more than 3 feet above the high-water line, a 10-foot (minimum) berm shall be constructed at this level, and the remaining slope constructed upward parallel with or on a flatter slope than the original natural bank, provided sufficient adjoining property is available.
 2. If such property is not available, permanent riprap shall be placed to the top of the bank. Permanent riprap material shall be placed from the bed of the channel to 3 feet above the normal high-water line or to the top of the bank. If riprap is placed to the top of the bank, a berm will not be required.

3. Permanent riprap shall be 5 to 1 mix of sand to cement in burlap or canvas bags, "Sacrete," broken concrete, man-sized rock, or other material approved by ENGINEER. "Sacrete," where used, shall be transferred to burlap or canvas bags.
 4. All raw soil exposed above the riprap shall be either sodded or seeded, fertilized, and mulched. On slopes greater than 10 percent, sod shall be pegged for stability.
- E. Slope Protection - Adjacent to Stream Crossings:
1. In clearing and grubbing of right-of-way, a 20-foot-deep strip of natural vegetation the full width of the right-of-way shall be left on both sides of the streams or drains to be crossed.
 2. Deflection dikes consisting of gravel or other suitable material, reinforced by 1 row of sandbags, shall be used to divert runoff from steep slopes adjacent to water crossing, where contributing runoff could be great enough to cause slope erosion and resulting sedimentation at the stream crossing.
 3. Diversion berms, filter berms, diversion ditches, or terracing may be appropriate. On slopes greater than 20 percent, such diversion structures shall be placed at the top of said slopes and at 100-foot intervals or less on the slope face. Similar diversion structures shall be placed along the top of the stream bank where the entire slope is not protected with riprap. Water shall be diverted to undisturbed areas adjacent to the right-of-way.
 4. A pipe trench excavation shall stop some distance from the stream to leave a protective plug of 10 to 20 feet of unexcavated material at each bank. The plugs shall be left in place until the pipe laying operation across the stream has begun.
 5. Bypassing of water in the trench to the side by diversion ditches or by pumping may be required. The water shall be diverted to undisturbed areas adjacent to the right-of-way.
 6. Replacing of bank plug and grading of stream banks within 50 feet of the stream shall be accomplished immediately following pipe laying. Clearing and the removal of protective vegetation shall be kept at a minimum distance ahead of the trenching unit.
- F. Slope Protection: On slopes greater than 20 percent, but not immediately adjacent to stream crossing, mulch shall be anchored with a spray of asphalt, Type SS-1S emulsion mixed with an equal amount of water at a rate of 200 gallons per acre. Chemical self-adhering mulch may be used. Mulch shall be anchored on slopes greater than 10 percent if immediately adjacent to stream crossings. Mulch may also be held in place by discing with a farm disc. If mulch materials such as netting or excelsior blankets are used, they may have to be pegged.
- G. Final Topography Protection: When final topography has been established, all bared soil shall be seeded, fertilized, and mulched in an effort to restore to a protected condition, except in flat, active farm fields. Critical areas shall be sodded as specified under Section 02315.
1. The permanent protection measures shall be in effect not more than 30 days after the earth change is completed, except at tie-in areas at both sides of the stream where temporary measures will be installed within 3 days following a pipeline crossing. Temporary measures may include a row of sandbags at the top of the bank, a row of pegged bales of straw, or an earth berm or diversion ditch. These temporary measures shall be maintained until permanent measures are installed.
 2. Where construction involves placing pipes in roadways or under other impervious materials, special care shall be provided by CONTRACTOR.
 3. Provide control measures at all storm sewer catch basins by providing straw or other types of filters or construct sediment traps adjacent to inlets.
 4. If a roadway has a grass ditch area, minimize disturbance and provide filter berms (straw or gravel) or sediment traps as appropriate.
 5. Provide proper downdrain structures to control increased runoff to streams and drains.

6. Stabilize the roadway as soon as possible after placement of the utility. Temporary erosion control measures shall be instituted until final paving is complete. Such measures may include a subbase surfacing application or gravel surfacing. Compaction of soil may suffice if other control measures are effected.

3.07 FIELD QUALITY CONTROL

- A. Any unforeseen situations that may be encountered during the course of construction that may cause accelerated erosion and deposition of sediment into waterways and/or lakes shall be controlled by methods that may include sediment traps, sediment basins, or holding ponds. Any slope failures or development of gullies after construction has been completed shall be corrected immediately.
- B. Should the local Regulatory Agency determine at any time during construction that the construction operation is in violation of the Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994 and cite OWNER, CONTRACTOR or Subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.

3.08 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour-day basis where required to achieve indicated results and to avoid possibility of damage.
- C. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- D. Termination and Removal: Unless ENGINEER requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of CONTRACTOR. OWNER reserves the right to take possession of Project identification signs.
 2. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period including, but not limited to:
 - a. Replace air filters and clean inside of ductwork and housings.
 - b. Replace significantly worn parts and parts that have been subject to unusual operating conditions.
 - c. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.

END OF SECTION

SECTION 01600 - GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. These General Equipment Stipulations apply, in general, to all equipment provided under other Specification Sections. They shall supplement the detailed equipment specifications, but in cases of conflict the equipment specifications shall govern.
- B. Related Sections: Electric and DC-driven motors are specified in Section 16220.

1.02 OPERATION AND MAINTENANCE

- A. All equipment suppliers shall submit to ENGINEER, through CONTRACTOR, 4 bound copies and 1 electronic/digital format copy of a manual containing specifications, Drawings, and descriptions of equipment; installation instructions; operation, maintenance, and lubrication manuals; parts lists; emergency instructions; and where applicable, test data with curves, wiring diagrams, PLC programs on CD and schematics. This information shall be submitted for each item of equipment furnished under this Contract and shall be specific to the exact equipment models complete with all appurtenances provided. It shall also include detailed, comprehensive directions for all required maintenance activities and for the repair or replacement of all wearing parts. Special attention shall be paid to necessary safety precautions that OWNER's staff should take when operating, maintaining, or repairing the equipment.
 - 1. Bound copies of O&M Manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.
 - 2. Electronic Copy of O&M Manuals: Each equipment O&M manual shall be provided with an electronic disk, matching the content of the final approved printed O&M Manual. The information shall be saved in a single ".pdf" file, with bookmarks for each chapter, section, appendices, etc., as well as each piece of equipment. Where numerous pieces of equipment may be addressed within a section, a second tier of bookmarks shall be provided to allow quick access to each piece of equipment or key piece of information.
 - 3. "Sample" Table of Contents:

Bookmarks

Table of Contents

Section 1 - Approved Shop Drawings

Submersible Pumps

Base-mounted Pumps

Section 2 - Installation Instructions and Parts Identification

Submersible Pumps

Base-mounted Pumps

Section 3 - Operations and Maintenance Information

Section 4 - Troubleshooting (If not included in Section 3.)

Section 5 - Parts List (If not included in Section 3.)

Section 6 - Lubrication Instructions (If not included in Section 3.)

4. These manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.

1.03 QUALITY ASSURANCE

- A. Compliance with OSHA: All equipment provided under this Contract shall meet all the requirements of the Federal and/or State Occupational Safety and Health Acts. Each equipment supplier shall submit to ENGINEER certification that the equipment furnished is in compliance with OSHA.
- B. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

1.04 SHIPPING AND HANDLING EQUIPMENT

- A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment and handling.

1.05 SPARE MATERIALS

- A. All V-belt driven equipment shall be furnished with a complete set of spare belts per each piece of equipment. When two or more similar pieces of equipment are furnished, replacement belt assemblies shall be furnished for every other drive assembly.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Anchor Bolts: Anchor bolts, nuts, and washers shall be hot-dipped galvanized in conformity with ASTM A 385 and be supplied with sleeves.
- B. Shop Painting:
 1. Non-submerged Applications: Tnemec Series 37H, Chem-Prime.
 2. Submerged, Non-potable Applications: Tnemec Series 66, Hi-Build Epoxoline.
 3. Submerged, Potable Applications: Tnemec Series 139, Pota-Pox II.
 4. Rust preventive compound shall be:
 - a. Dearborn Chemical, No-Ox-ID2W.

- b. Houghton, Rust Veto 344.
- c. Rust-Oleum R-9.

2.02 MANUFACTURED UNITS

- A. Wall and Slab Sleeves and Castings: Where water- or gas-tightness is essential and at other locations where indicated, wall castings and sleeves shall be provided with an intermediate flange located approximately at the center of the wall or slab.
 - 1. All sleeves and casting shall be flush with walls and underside of slabs but shall extend 2 inches above finished floors.

2.03 COMPONENTS

- A. Lubrication: Equipment shall be adequately lubricated by systems which require attention no more often than weekly during continuous operation. Lubrication system shall not require attention during start-up or shutdown and shall not waste lubricants.
 - 1. Lubrication point shall be easily accessible with all points of application provided with standard fittings for greasing or placing oil.
 - 2. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity for all consumption prior to completion of required testing and acceptance of equipment by OWNER.
- B. Safety Guards: All belt or chain drives, fan blades, couplings, vertical or horizontal drive shafts, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 gauge or heavier galvanized or aluminum-clad sheet steel or 1/2-inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and painted safety yellow.
 - 1. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be hot-dipped galvanized.
 - 2. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
- C. Anchor Bolts: All necessary anchor bolts shall be provided as per the manufacturer's recommendations for size, strength, and location and shall meet the requirements of Standard Details on Drawings. Substantial templates and working drawings for installation shall be provided. Two nuts shall be furnished.
 - 1. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.
- D. Seals: Mercury seals will not be acceptable.
- E. Bearings: All antifriction bearings shall be designed per the Anti-Friction Bearing Manufacturers Association (AFBMA) recommendations with a rating life of B-10, 30,000 hours.
- F. Equipment Bases: A cast iron or welded steel baseplate shall be provided for all equipment and motor assemblies. Each baseplate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have a threaded drain connection. Bases shall be fully braced to withstand shock loads and resist buckling. Necessary safety guard mounting shall be provided as part of the equipment base.

- G. Motor Starters and Control Panels: Motor starters 480 volt or less shall be size one or larger and have 120 volt AC contactor coils. All control circuits and indicating lights associated with the starter shall be 120 volt. The control transformer shall be sized to have 100 VA minimum spare capacity for future use. A terminal strip shall be provided for all control wires entering the starter with spare terminals for future use. The terminal strip and wires shall be identified. One spare normally open auxiliary starter contact, wired to the terminal strip, shall be provided for future use. Indicating lights shall be 120 volt, oiltight, push-to-test type. Explosion-proof units shall meet NEC Class I, Division I, Group D requirements.
 - 1. Provide equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction, such as NEMA 4, 4X, 7, or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.

2.04 FABRICATION

- A. Shop Painting: All iron and steel surfaces shall be protected by suitable paint or coatings applied in the shop or at point of fabrication. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment.
 - 1. All iron and steel surfaces which will be totally or partially submerged or located in a continuously or intermittently moist atmosphere during normal operation shall be shop blast cleaned to a near-white finish, removing all dirt, rust-scale, and foreign matter by any of the recommended methods outlined in the Steel Structures Painting Council Specification SP-10.
 - 2. The cleaned surfaces shall be shop primed before any rust bloom forms. All other exposed surface shall be properly filed, scraped, sanded, etched, brushed, sandblasted, and/or cleaned to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease and shop primed.
 - 3. Shop primed surfaces shall be painted with one or more coats of a primer which meets the requirements of this Section and is compatible with the finish painting system specified in Section 09900. Minimum shop coat thickness shall be 1.5 dry mills.
- B. Sluice gates shall be factory painted with coal tar.
- C. The exterior surfaces of all ground-buried valves shall receive a coal tar or bituminous coating in accordance with manufacturer's standards. The inside surfaces of all valves shall be coated with coal-tar pitch varnish in accordance with the latest AWWA Specifications.
- D. Electric motors, speed reducers, starters, pumps, motor control centers, control panels, and other self-contained or enclosed components shall be shop finished with 2 coats of an enamel paint as per manufacturer's recommendations.
- E. Where specified, steel and iron surfaces shall be hot-dipped galvanized in conformity with ASTM A 153 and A 385.
- F. Machined, polished, and nonferrous surfaces which are not to be painted or galvanized shall be coated with rust preventive compound.

PART 3 - EXECUTION

3.01 EQUIPMENT BASES

- A. The baseplate shall be installed on a concrete base. Baseplates shall be anchored to the concrete base with suitable anchor bolts and grouted in place.

3.02 WALL AND SLAB SLEEVES AND CASTINGS

- A. Unless otherwise shown on Drawings or specified, at all points where pipes or conduit pass through walls, slabs or roofs, suitable sleeves or castings shall be furnished and installed. Sleeves and castings shall not be painted in areas to be embedded in the concrete. All loose rust, scale, grease, or oil shall be removed prior to pouring the concrete.
- B. Unless otherwise shown or approved by ENGINEER, the space between the pipe and the sleeve shall be caulked. All ground buried and water or gas retaining wall or slab sleeves or castings shall be caulked with lead and oakum or be mechanical joint.

3.03 EQUIPMENT INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment shall visit Site of Work a minimum of 2 times, once prior to installation to review installation procedures with CONTRACTOR and once after installation to inspect, check, adjust if necessary, and approve the equipment's installation. The equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Each equipment supplier's representative shall furnish to OWNER, through ENGINEER, a written report certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER;
 - 5. That OWNER's Representative has been instructed in the proper maintenance and operation of the equipment; and
 - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

3.04 OPERATION AND MAINTENANCE TRAINING

- A. Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
 - 1. Manufacturer's representative shall provide 1 day, 8 hours, on-Site training.
 - 2. Review operating and maintenance data contained in the operating and maintenance manuals.
 - 3. Schedule training with OWNER, provide at least 7-day prior written notice to ENGINEER.

END OF SECTION

SECTION 01640 - INSTALLATION OF OWNER-FURNISHED EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: Provide all labor, materials, tools, equipment, accessories, and services necessary for receiving, unloading, storing, installing equipment, and testing items as specified in this Section. OWNER has executed a contract with the equipment manufacturer and has assigned the equipment to CONTRACTOR. The equipment shall be installed by CONTRACTOR as provided in this Section.
- B. Related Sections: Additional requirements for equipment to be installed under this Section are specified in:
- C. Equipment Supplier's Approved Proposals and Equipment Shop Drawings: Equipment proposal and description of equipment from supplier to be installed under this Section of the Work is included in Appendix A.
- D. Equipment Manufacturer's Erection Drawings: Erection drawings and installation instructions for the equipment to be installed under this Section of the Work are available for review in the office of ENGINEER and in the office of the local representatives for the manufacturer. The name and address for the local representative is listed below:
 1. Equipment Item:
 - a. Contact Name Julia Hahn
 - b. Company Huber Technology Inc
 - c. Address 1009 Airlie Parkway
 - d. City, State, Zip Denver NC28037
 - e. Phone: 704-990-2443
 - f. Fax: 704-949-1020
 - g. Email: Julia.hahn@hhusa.net

1.02 QUALITY ASSURANCE

- A. Tests: Performance testing, if required, shall be accomplished by the equipment manufacturer unless specifically specified hereinafter under individual items.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site: The Work shall include receiving and unloading the equipment items specified upon their arrival at Site, storing and protecting the equipment in accordance with the supplier's recommendations and this Specification prior to erection, erecting the equipment in accordance with instructions and erection drawings provided by the equipment supplier and approved by ENGINEER, installation of anchor bolts and foundations, grouting of all baseplates, performance testing, and repair of shop coatings marred or damaged after the equipment has arrived at Site.
- B. The equipment supplier shall be responsible for delivery of the equipment to Site in undamaged condition. It shall be pre-assembled to the degree indicated in the approved Shop Drawings. Repair of equipment defects or damage to coatings incurred prior to the arrival of the equipment at Site shall be the responsibility of the equipment supplier. CONTRACTOR shall thoroughly inspect the

equipment prior to unloading for damage or evidence of mishandling. Any damage shall be inspected by ENGINEER and/or the equipment supplier prior to the unloading of the equipment at Site.

- C. Physical damage to the equipment during unloading, storage, or installation shall either be repaired by the equipment supplier at CONTRACTOR's expense, or repaired by CONTRACTOR under the supervision of and in accordance with instructions of the equipment supplier.
- D. Description: Equipment to be installed under this Section includes:
 - 1. Huber Screw Press - two
 - 2. Dewatered Cake Conveyors – Five
 - 3. Polymer Blending Unit - two
 - 4. Air Compressor – two
 - 5. Instrumentation
 - 6. Control Panels

1.04 COMMISSIONING

- A. All labor and materials required for testing or placing equipment in operation after the equipment has been properly installed and the installation approved by the equipment supplier and ENGINEER shall be provided by the equipment supplier unless otherwise specifically noted.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Equipment and material supplied to facilitate installation, or appurtenant to the equipment installed under this Section, shall comply with the requirements of the various specification Sections where these items are specified.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer as approved by ENGINEER.

3.02 INSTALLATION ACCEPTANCE

- A. Installation shall be considered complete when the equipment supplier approves the installation and, after performance testing, informs ENGINEER of acceptance of the installation in writing; and installation is accepted by ENGINEER.
- B. The Certificate of Component Acceptance, in Section 00625, shall be completed after the installation has been accepted by CONTRACTOR, OWNER, and ENGINEER.

END OF SECTION

SECTION 01730 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for cutting and patching.
- B. Related Sections:
 - 1. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work. Requirements of this Section apply to mechanical and electrical installations. Refer to Division 15 and Division 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.
 - 2. Demolition of selected portions of the building for alterations is included in Section 02225.

1.02 SUBMITTALS

- A. Cutting and Patching Proposed Method: Where approval of procedures for cutting and patching is required before proceeding, submit a proposal describing procedures well in advance of the time cutting and patching will be performed and request approval from ENGINEER to proceed.

1.03 QUALITY ASSURANCE

- A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.
- B. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance or decreased operational life or safety.
- C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in ENGINEER's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance shall equal or surpass that of existing materials.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Before cutting existing surfaces, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.

3.02 PREPARATION

- A. Provide temporary support of Work to be cut.
- B. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Take all precautions necessary to avoid cutting existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.

3.03 PERFORMANCE

- A. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
- B. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
- C. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with the original installer's recommendations.
 - 1. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
- D. Comply with requirements of applicable Sections of Division 2 where cutting and patching requires excavating and backfilling.
- E. Cap, valve or plug, and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.
- F. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Patch, repair or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.04 CLEANING

- A. Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty, and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

END OF SECTION

SECTION 01770 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Contract closeout including, but not limited to:
 - 1. Warranties and Bonds.
 - 2. Requirements for Substantial Completion.
 - 3. Project record document submittal.
 - 4. Equipment acceptance.
 - 5. Operating and maintenance manual submittal.
 - 6. Final cleaning.
- B. Refer to the General Conditions for terms of CONTRACTOR's special warranty of workmanship and materials.
- C. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions 2 through 16.
- D. Certifications and other commitments and agreements for continuing services to OWNER are specified elsewhere in the Contract Documents.

1.02 WARRANTY REQUIREMENTS

- A. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve CONTRACTOR of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with CONTRACTOR.
- B. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. CONTRACTOR is responsible for the cost of replacing or rebuilding defective Work regardless of whether OWNER has benefited from use of the Work through a portion of its anticipated useful service life.
- E. OWNER's Recourse: Written warranties made to OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which OWNER can enforce such other duties, obligations, rights, or remedies.

- F. Rejection of Warranties: OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- G. OWNER reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.03 SUBSTANTIAL COMPLETION

- A. Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
 - 2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
 - 3. Advise OWNER of pending insurance changeover requirements.
 - 4. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
 - 5. Obtain and submit releases enabling OWNER unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates, and similar releases.
 - 6. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- B. Inspection Procedures: On receipt of a request for inspection, ENGINEER will either proceed with inspection or advise CONTRACTOR of unfilled requirements.
 - 1. ENGINEER will prepare the Certificate of Substantial Completion following inspection, or advise CONTRACTOR of construction that must be completed or corrected before the certificate will be issued.
 - 2. ENGINEER will repeat inspection when requested and assured that the Work has been substantially completed.
 - 3. Results of the completed inspection will form the basis of requirements for final acceptance.
- C. The warranty period for specific portions of the Work will begin on the date established on Component Acceptance Form or at such other date as agreed by OWNER, ENGINEER, and CONTRACTOR.

1.04 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
 - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 - 2. Submit an updated final statement, accounting for final additional changes to the Contract Price.
 - 3. Submit a copy of ENGINEER's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by ENGINEER.

4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion, or when OWNER took possession of and responsibility for corresponding elements of the Work.
 5. Submit consent of surety to final payment.
 6. Submit a final liquidated damages settlement statement.
 7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 8. Submit record drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information.
 9. Deliver tools, spare parts, extra stock, and similar items.
 10. Make final changeover of permanent locks and transmit keys to OWNER. Advise OWNER's personnel of changeover in security provisions.
 11. Complete start-up testing of systems, and instruction of OWNER's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- B. Reinspection Procedure: ENGINEER will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to ENGINEER.
1. Upon completion of reinspection, ENGINEER will prepare a certificate of final acceptance, or advise CONTRACTOR of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated.

1.05 SUBMITTALS

- A. Submit written warranties to ENGINEER prior to the date certified for Substantial Completion. If ENGINEER's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of ENGINEER.
- B. When a designated portion of the Work is completed and occupied or used by OWNER, by separate agreement with CONTRACTOR during the construction period, submit properly executed warranties to ENGINEER within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by CONTRACTOR, or CONTRACTOR and a subcontractor, supplier, or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to OWNER through ENGINEER for approval prior to final execution.
- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

1.06 RECORD DOCUMENT SUBMITTALS

- A. Record Drawings:
 1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown.
 2. Mark whichever Drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on Contract

- Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
3. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
 4. Mark new information that is important to OWNER, but was not shown on Contract Drawings or Shop Drawings.
 5. Note related Change Order numbers where applicable.
 6. Organize Record Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates, and other identification on the cover of each set.
- B. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work.
1. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to ENGINEER for OWNER's records.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 COMPONENT ACCEPTANCE

- A. Component Acceptance Certificate: For each item of equipment incorporated into the Project, ENGINEER will issue a Component Acceptance Certificate as shown in Section 00625.
- B. The certificate will certify that the equipment installation is complete, that manufacturer-provided inspection and start-up services and training have taken place, and that OWNER has beneficial use of the equipment.
- C. The data on the Component Acceptance Certificate may be used to establish the time of beginning for the warranty period for that piece of equipment, if OWNER begins to use it at that time.

3.02 FINAL CLEANING

- A. General cleaning during construction is required by the General Conditions and included in Section 01500.
- B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- C. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 1. Remove labels that are not permanent labels.

2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 5. Clean Site, including landscape development areas, of rubbish, litter, and foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth even-textured surface.
- D. Pest Control: Engage an experienced exterminator to make a final inspection, and rid Site of rodents, insects, and other pests.
- E. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning.
1. Do not burn waste materials. Do not bury debris or excess materials on OWNER's property.
 2. Do not discharge volatile, harmful, or dangerous materials into drainage systems.
 3. Remove waste materials from Site and dispose of in a lawful manner.
- G. Where extra materials of value remaining after completion of associated Work have become OWNER's property, arrange for disposition of these materials as directed.

END OF SECTION

SECTION 02225 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Selective Demolition Work requires selective removal and off-Site disposal of following:
 - 1. Portions of building structure shown on Drawings or required to accommodate new construction.
 - 2. Removal of interior partitions marked "remove" on Drawings.
 - 3. Removal of doors and frames marked "remove" on Drawings. Removal of built-in casework marked "remove" on Drawings. Removal of existing windows shown as "bricked-in".
 - 4. Removal and protection of existing fixtures and equipment items shown or marked as "remove and salvage."
 - 5. Removal, protection, and reinstallation of existing fixtures and equipment items shown or marked as "remove and reinstall."
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 DEFINITIONS

- A. Remove: Remove and dispose of items shown or scheduled. Discard demolished or removed items except for those shown to remain, those shown as reinstalled, those shown as salvaged, and historical items that are to remain OWNER's property.
- B. Remove and Salvage: Items shown as "remove and salvage" remain OWNER's property. Carefully remove and clean salvage items; pack or crate to protect against damage.
- C. Remove and Reinstall: Remove items shown; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in same location or in location shown.
- D. Existing to Remain: Protect construction or items shown to remain against damage during selective demolition operations. When permitted by ENGINEER, CONTRACTOR may elect to remove items to suitable, protected storage location during selective demolition and properly clean and reinstall items in their original locations.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Proposed dust control measures.
 - 2. Proposed noise control measures.
 - 3. Proposed haul routes between Site and disposal areas before commencing this Work.
- B. Submit Schedules listed below to OWNER.
 - 1. Detailed sequence of selective demolition and removal Work, with starting and ending dates for each activity.
 - 2. Inventory list of removed existing equipment not reused in Contract Work. Submit lists to OWNER. OWNER to determine or select items for retention by OWNER.

3. Inventory list of removed and salvaged items.
 4. Inventory list of OWNER-removed items.
 5. Interruption of utility service.
 6. Coordination for shutoff, capping, and continuation of utility services.
 7. Use of elevator and stairs. Detailed sequence of selective demolition and removal Work to ensure uninterrupted progress of OWNER's on-Site operations.
 8. Coordination of OWNER's continuing occupancy of portions of existing building and of OWNER's partial occupancy of completed Work.
 9. Locations of temporary partitions and means of egress.
- C. Inventory list of existing equipment to be removed and not reused in Work. OWNER to determine or select items for retention by OWNER.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Demolition operations shall comply with OSHA and EPA requirements and EPA notification regulations insofar as they apply to selective demolition Work under this Contract.
 2. Comply with hauling and disposal regulations of authorities having jurisdiction.
 3. If hazardous materials are found during selective demolition operations, comply with applicable paragraphs of General Conditions.
- B. Pre-Installation Meetings:
1. Do not close, block, or obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction.
 - a. Use alternative routes around closed or obstructed routes if required by governing regulations.
 2. Coordinate with OWNER's continuing occupation of portions of existing building, with OWNER's partial occupancy of completed new addition, and with OWNER's reduced usage during summer months.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Disassemble or cut large equipment items into smaller pieces to promote safe removal and transportation.
1. Transport and unload items requested by OWNER at designated Site within distance of 5 miles.
 2. Haul away and dispose of debris and materials neither retained by OWNER, nor reused or reinstalled.
 3. Arrange for disposal areas.
 4. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- B. Unloading Salvage Items: Where shown on Drawings as "Remove and Salvage," carefully remove shown items, clean, store, and turn over to OWNER and obtain receipt. OWNER will designate site for receiving items.
- C. Handling: CONTRACTOR shall take every precaution to prevent spillage of materials being hauled in public streets.
1. It shall be CONTRACTOR's responsibility to immediately clean spillage that may accidentally occur.
 2. Do not burn removed material on or within Project Site.

1.06 PROJECT CONDITIONS

- A. Materials Ownership:
 - 1. Salvage Materials: Demolished materials shall become CONTRACTOR's property, except for items or materials shown as reused, salvaged, reinstalled, or otherwise shown to remain OWNER's property. Remove demolished material promptly from Site with further disposition at CONTRACTOR's option.
 - 2. Historical artifacts, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historical significance remain property of OWNER. Notify OWNER's Representative when these items are found and obtain method of removal and salvage from OWNER.
 - 3. Transport items of salvageable value to CONTRACTOR (CONTRACTOR's area) as they are removed. Storage or sale of demolition items on-Site is not allowed.
- B. Environmental Requirements: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations relating to environmental protection. Do not use water when it may create hazardous or objectionable conditions including ice, flooding, and pollution.
- C. Existing Conditions: OWNER will be continuously occupying building areas immediately adjacent to selective demolition areas.
- D. OWNER assumes no responsibility for actual condition of items or structures scheduled for selective demolition.
- E. OWNER will maintain conditions existing at Contract commencement insofar as practical. However, variations within structure may occur by OWNER's removal and salvage operation before selective demolition Work begins.

1.07 SEQUENCING

- A. Conduct selective demolition Work in manner that minimizes need for disruption or interference of OWNER's normal on-Site operations.
- B. Coordinate with OWNER's continuing occupation of portions of existing building, with OWNER's partial occupancy of completed new addition and OWNER's reduced usage during summer months.
- C. Include coordination for shutoff, capping, and continuation of utility services together with details for dust and noise control protection to ensure uninterrupted on-Site operations by OWNER.

1.08 SCHEDULING

- A. Schedule: Submit schedule showing proposed methods and sequence of operations for selective demolition Work to OWNER's Representative for review before commencement of Work.
- B. Arrange selective demolition schedule so as not to interfere with OWNER's on-Site operations.
- C. Give minimum of 72 hours advance notice to OWNER of demolition activities which affect OWNER's normal operations.

- D. Give minimum of 72 hours advance notice to OWNER if shutdown of service is necessary during changeover.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Before beginning selective demolition Work, inspect areas of Work. Survey existing conditions and correlate with requirements shown to determine extent of selective demolition required. Photograph existing structure surfaces, equipment, or surrounding properties which could be misconstrued as damage resulting from selective demolition Work. File with OWNER's Representative before starting Work.
- B. Inventory and record condition of items scheduled as "remove and re-install" or items scheduled as "remove and salvage."
- C. Verify disconnection and capping of utilities within the affected area of Work.
- D. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design, investigate and measure nature and extent of conflicts. Promptly submit detailed written reports to OWNER's Representative. Pending receipt of the directive from OWNER's Representative, rearrange selective demolition schedule to continue general job progress without delay.
- E. Demolition includes but is not limited to the following;
 - 1. Centrifuges
 - 2. Centrifuges feed pumps
 - 3. Conveyor
 - 4. Polymer preparation and feed equipment
 - 5. Odor Control Unit
 - 6. Flowmeter
 - 7. Sludge piping and valves
 - 8. Sludge Transfer Pumps
 - 9. Aeration Blowers
 - 10. Aeration Piping
 - 11. Submersible Mixers
 - 12. Concrete pads and slabs
 - 13. Door
 - 14. Electrical and Instrumentation associated with demolished equipment

3.02 UTILITY SERVICES

- A. Where utility services are scheduled for removal, relocation, or abandonment, install bypass connections and temporary service to maintain continuity of services to other building parts before proceeding with selective demolition.
- B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction.
- C. Maintain existing utilities shown as remaining. Keep in service and protect existing utilities against damage during selective demolition operations.
- D. Locate, identify, stub off, and disconnect utility services that are not to remain active.
 - 1. OWNER will arrange to shut off designated utilities when requested by CONTRACTOR.
 - 2. Arrange to shut off utilities with utility companies.
- E. Cut off pipe or conduit in walls or partitions scheduled for removal. Cap, valve or plug, and seal remaining portion of pipe or conduit after bypassing.

3.03 PREPARATION

- A. Drain, purge, or remove, collect and dispose of chemicals, gases, explosives, acids, flammable, or other dangerous material before proceeding with selective demolition operations.
- B. Cover and protect furniture, equipment, and permanent fixtures from soiling or damage while demolition Work is done in rooms or areas where items remain in place.
- C. Protect existing finish Work that remains in place and becomes exposed during selective demolition operations.
- D. Protect floors with suitable coverings when necessary.
- E. Where selective demolition occurs immediately adjacent to occupied portions of building, or to separate areas of noisy or extensive dirt or dust operations, construct and maintain temporary, insulated, fire-rated solid dustproof partitions.
 - 1. Construct dustproof partitions of minimum 4-inch studs, 5/8-inch-thick drywall (joints taped on occupied side), 1/2-inch fire-retardant plywood on demolition side, and fill partition cavity with sound-deadening insulation.
 - 2. Equip partitions with dustproof doors and security locks if required.
- F. Provide weatherproof closures for exterior openings resulting from selective demolition Work. Provide temporary weather protection during interval between selective demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- G. Provide and ensure free and safe passage of OWNER's personnel and general public to and from occupied portions of building around selective demolition areas.
 - 1. Provide temporary barricades and other forms of protection to protect OWNER's personnel and general public from injury.
 - 2. Build temporary covered passageways required by authorities having jurisdiction.

- H. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of demolished structures or elements, or adjacent facilities or Work to remain.
- I. Cease operations and notify OWNER's Representative immediately if safety of structure seems endangered. Take precautions to support structure until determination is made for continuing operations.
- J. Remove protection at completion of Work.

3.04 DEMOLITION

- A. Special Techniques: Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. Demolish foundation walls to depth of not less than 12 inches below proposed ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.
- C. For interior slabs on grade, use power saw or removal methods that do not crack or structurally disturb adjacent slabs or partitions.
- D. Completely fill below-grade areas and voids resulting from selective demolition Work. Either:
 - 1. Provide fill consisting of approved earth, gravel, or sand.
 - 2. Fill shall be free of trash, debris, stones over 6-inch diameter, roots, or other organic matter.OR
 - 3. Fill below-grade areas and voids with Class F concrete.
- E. Explosives: Use of explosives is not allowed.
- F. Interface with Other Work: Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
- G. Site Tolerances: Provide services for effective air and water pollution controls required by local authorities having jurisdiction.

3.05 REPAIR\RESTORATION

- A. Repair damages caused by demolition that was more extensive than required.
- B. Return structures and surfaces to condition existing before commencement of selective demolition Work.
- C. Repair adjacent construction or surfaces soiled or damaged by selective demolition Work.
- D. Promptly repair damages caused to adjacent facilities by selective demolition Work at no cost to OWNER.

3.06 CLEANING

- A. CONTRACTOR shall maintain an order of neatness and good housekeeping comparable to that observed by OWNER.
- B. Keep tools, scaffolding, and other demolition equipment in neat and orderly arrangement.
- C. Remove dirt and debris resulting from CONTRACTOR's demolition operations from Site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations.
- D. Upon completion of selective demolition Work, remove tools, equipment, and demolished materials from Site. Remove protection and leave interior areas broom clean.

END OF SECTION

SECTION 02310 - EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Preparing of subgrade for building slabs, walks, and pavements.
 - 2. Aggregate base courses for walks and pavements, aggregate surface courses, and aggregate shoulders.
 - 3. Drainage fill course for support of building slabs is included as part of this Work.
 - 4. Excavating and backfilling of trenches within building lines.
 - 5. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
- B. Final Grading, placement, and preparation of topsoil for lawns, planting, and paving are specified in other Division 2 Sections.

1.02 DEFINITIONS

- A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
- B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of ENGINEER. Unauthorized excavation, as well as remedial Work directed by ENGINEER, shall be at CONTRACTOR's expense.
 - 1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to ENGINEER.
 - 2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification unless otherwise directed by ENGINEER.
- C. Additional Excavation: When excavation has reached required subgrade elevations, notify ENGINEER, who will make an inspection of conditions. If ENGINEER determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by ENGINEER. The Contract Price may be adjusted by an appropriate Contract Modification.
 - 1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in Work.
- D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
- E. Subbase: The layer of specified materials of designed thickness placed to the subgrade as part of the pavement structure.
- F. Base Course: The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.

- G. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

1.03 SUBMITTALS

- A. Test Reports: Submit the following reports directly to ENGINEER from the testing services, with copy to CONTRACTOR:
 - 1. Test reports on borrow material.
 - 2. Verification of suitability of each footing subgrade material in accordance with specified requirements.
 - 3. Gradation analysis for subbase and base materials.
 - 4. Field reports; in-place soil density tests will be performed by a representative of OWNER.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation Work in compliance with applicable requirements of authorities having jurisdiction. Construct subbase, base, and surface courses in accordance with Michigan Department of Transportation (MDOT) Standard Specifications for Construction.
- B. Testing and Inspection Service: OWNER will employ and pay for a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations.

1.05 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities in areas of excavation Work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by OWNER or others, during occupied hours, except when permitted in writing by ENGINEER, and then only after acceptable temporary utility services have been provided.
 - 3. Provide minimum of 48-hour notice to ENGINEER, and receive written notice to proceed before interrupting any utility.
 - 4. Demolish and completely remove from Site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- B. Use of Explosives: Use of explosives is not permitted.
- C. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
 - 1. Operate warning lights as recommended by authorities having jurisdiction.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - 3. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GW, GP, GM, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
- C. Sand Bedding and Backfill: MDOT Specifications - Granular Materials Class III.
- D. Subbase Material: MDOT Specifications - Granular Materials Class II.
- E. Aggregate Base: Aggregate shall meet MDOT Specification 21AA or 22A.
- F. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 4 sieve.
- G. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- H. Aggregate Surfaces and Shoulders: Surfaces on which no bituminous or concrete pavement is to be placed shall meet MDOT Specification 23A or 22A.
- I. Private Driveways: Surfaces on which no bituminous or concrete pavement is to be placed, and where no other material is specified, shall meet MDOT Specification 23A or 22A.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.
- B. Excavation Classifications: The following classifications of excavation will be made when rock is encountered:
 - 1. Earth excavation includes excavation of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
 - 2. Rock excavation for trenches and pits includes removal and disposal of materials and obstructions encountered that cannot be excavated with a track-mounted power excavator, equivalent to Caterpillar Model No. 215C LC, and rated at not less than 115 horsepower flywheel power and 32,000-pound drawbar pull and equipped with a short stick and a 42-inch wide, short tip radius rock bucket rated at 0.81 cubic yard (heaped) capacity. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.
 - 3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered that cannot be dislodged and excavated with modern, track-mounted,

heavy-duty excavating equipment without drilling, blasting, or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973, or equivalent track-mounted loader, rated at not less than 210 horsepower flywheel power and developing minimum of 45,000-pound breakout force (measured in accordance with SAE J732).

- a. Typical of materials classified as rock are boulders 1/2 cubic yard or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.
 - b. Intermittent drilling, blasting, or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
- C. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by ENGINEER. Such excavation will be paid on basis of Contract Conditions relative to changes in Work.
- D. Rock payment lines are limited to the following:
1. Two feet outside of concrete work for which forms are required, except footings.
 2. One foot outside perimeter of footings.
 3. In pipe trenches, 6 inches below invert elevation of pipe and 2 feet wider than inside diameter of pipe, but not less than 3 feet minimum trench width.
 4. Outside dimensions of concrete work where no forms are required.
 5. Under slabs on grade, 6 inches below bottom of concrete slab.

3.02 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
 1. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

3.03 DEWATERING

- A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area or from impacting the subgrade.
 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 2. Remove subsurface water below structure excavations until the water level is far enough below the subgrade elevation to allow the required subgrade compaction. Dewatering shall be completed before the subgrade is exposed and before ENGINEER inspects the subgrade

condition. Place dewatering wells outside the load-bearing influence area of the structure foundation. Provide test pits, well points, piping, pumps, electrical power, and other equipment necessary for dewatering.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.04 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
 1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
 2. Excess material to be stored on-site as indicated by Owner. Utilize excess material for berm construction as shown on grading plan. Approval of excess materials to be obtained by engineer prior to applying materials to berm construction.
 3. Material not approved for berm construction shall be disposed of onsite.

3.05 EXCAVATION FOR STRUCTURES

- A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
 2. For pile foundations, stop excavations from 6 to 12 inches above bottom of footing before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.

3.06 EXCAVATION FOR PAVEMENTS

- A. Cut surface under pavements to comply with cross-sections, elevations, and grades as indicated.

3.07 TRENCH EXCAVATION FOR PIPES AND CONDUIT

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
- B. Excavate trenches for conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line or to elevations as shown on Drawings.
 1. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of sand or pea gravel prior to installation of pipe.

2. For pipes or conduit less than 6 inches in nominal size, and for flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
3. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Where the subgrade is disturbed, fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

3.08 BACKFILL AND FILL

- A. Place and compact sand to a level 1 foot above the top of the pipe or conduit, then place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
 1. Under grassed areas, use satisfactory excavated or borrow material.
 2. Under walks and pavements, use subbase material, satisfactory excavated, or borrow material, or a combination.
 3. Under steps, use subbase material.
 4. Under building slabs, use drainage fill material.
 5. Under piping and conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
 6. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
 - a. Concrete is specified in Division 3.
 - b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by ENGINEER. Use care in backfilling to avoid damage or displacement of pipe systems.
- B. Backfill excavations as promptly as Work permits, but not until completion of the following:
 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
 3. Removal of concrete formwork.
 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 5. Removal of trash and debris from excavation.
 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.09 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
 1. When existing ground surface has a density less than that specified in this Article for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

- B. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
- E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by ENGINEER if soil density tests indicate inadequate compaction.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
 - a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
 - c. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
 - a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.10 GRADING

- A. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:
 - 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
 - 2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 - 3. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.

- C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge.
- D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.11 PAVEMENT SUBBASE COURSE

- A. Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support a pavement base course.
 - 1. Refer to other Division 2 Sections for paving specifications.
- B. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of subbase course.
- C. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
 - 1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 15 inches thick, place material in equal layers, except no single layer more than 8 inches or less than 3 inches in thickness when compacted. Subgrade shall be compacted to 95 percent maximum density.

3.12 AGGREGATE BASE COURSE

- A. Aggregate base course consists of placing base materials of the type and thickness, over a prepared subgrade or subbase, as shown on Drawings.
- B. Placing: Aggregate base shall be placed in accordance with MDOT Specifications. Aggregate base shall be conditioned in accordance with Method No. 2.

3.13 AGGREGATE SURFACE COURSE

- A. Aggregate surface courses consist of constructing an aggregate surface on prepared subgrade or subbase, an aggregate base or an existing aggregate surface.
- B. Placing: Aggregate surface courses shall be constructed in accordance with MDOT Specifications.

3.14 AGGREGATE SHOULDERS

- A. Aggregate shoulders and approaches shall be constructed to the thickness and dimensions as shown on Drawings.
- B. Placing: Aggregate shoulders and approaches shall be constructed in accordance with MDOT Specifications for Class III shoulders.

3.15 BUILDING SLAB DRAINAGE COURSE

- A. Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.
 - 1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.16 FIELD QUALITY CONTROL

- A. Quality Control Testing during Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

3.17 EROSION CONTROL

- A. Provide erosion control methods in accordance with details shown on Drawings and/or requirements of authorities having jurisdiction.

3.18 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas during general Project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal to Designated Areas on OWNER's Property: Transport acceptable excess excavated material to designated soil storage areas on OWNER's property. Stockpile soil or spread as directed by ENGINEER.
 - 1. Transport waste material, including unacceptable excavated material, trash, and debris to designated spoil areas on OWNER's property and dispose of as directed.
- B. Removal from OWNER's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off OWNER's property.
 - 1. Remove excess excavated material, trash, debris, and waste materials and dispose of it off OWNER's property.

END OF SECTION

SECTION 02635 - MANHOLES AND CATCH BASINS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of manholes and catch basins including inlets as detailed on Drawings and at the locations shown on Drawings. Concrete, excavation, and backfill shall be as specified here. Manholes and catch basins shall be complete with frames, covers, and steps. Adjustment of frames, inlets, etc., on new manholes and catch basins to meet new or existing pavement surfaces or sidewalks shall be included in Work under this Section.

1.02 REFERENCES

- A. Reference Standards:
1. ASTM A 48 Gray Iron Castings.
 2. ASTM A 536 Ductile Iron Castings.
 3. ASTM C 55 Concrete Building Brick.
 4. ASTM C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 5. ASTM C 139 Concrete Masonry Units for Construction of Catch Basins and Manholes.
 6. ASTM C 443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 7. ASTM C 472 Test Method for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete.
 8. ASTM C 478 Precast Reinforced Concrete Manhole Sections.
 9. ASTM C 923 Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Dimensions and reinforcement of precast concrete units, joint details, orientation and elevation of preformed openings in riser sections, pipe-to-manhole connection details, casting details, and certification papers.
- B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.
- C. Quality Control Submittals: All precast concrete manhole sections, resilient connectors between manhole sections and pipes and castings delivered to Site shall be preceded or accompanied by certification papers or stamped markings showing that the materials have been tested in accordance with applicable standard testing procedures and that the materials meet the Specifications for this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cast Iron Manhole Steps:
 - a. James B. Clow and Sons.
 - b. East Jordan Iron Works.
 - c. Neenah Foundry Co.
 - 2. Steel-Reinforced Manhole Plastic Steps:
 - a. Cast-in-Place:
 - 1) M.A. Industries, Inc. PS1-PF.
 - 2) American Step Co., Inc. P1-10.
 - b. Masonry:
 - 1) M.A. Industries, Inc. PS1-B.
 - 2) American Step Co., Inc. MSN-10.
 - c. Mechanical Lock:
 - 1) M.A. Industries, Inc. PS1-PF.
 - 2) American Step Co., Inc. ML-10.
 - 3. Frames and Covers:
 - a. James B. Clow and Sons.
 - b. East Jordan Iron Works.
 - c. Neenah Foundry Co.

2.02 MANHOLES

- A. Manholes on new sanitary sewers of 48-inch diameter and smaller shall be precast reinforced concrete with flexible watertight connections between the manhole wall and the sewer pipe.
- B. Manholes on new or existing storm sewers, water mains, and pumping mains, shall be precast reinforced concrete unless otherwise noted on Drawings.
- C. Manhole slabs shall be constructed of Class A concrete; manhole channels and fillets shall be constructed of Class C concrete, as specified under Division 3, according to the details given on Drawings. Unless otherwise directed, all surfaces of concrete channels and fillets shall be screeded and floated to a smooth, uniform surface and troweled to a hard finish.

2.03 CATCH BASINS

- A. Catch basins shall be constructed of precast reinforced concrete units. These precast units shall conform to the requirements of ASTM. Inside grouting with either cold-applied, ready-to-use plastic joint-sealing compound or rubber gasket shall be used to connect the units.
 - 1. As an alternate, the use of concrete manhole block conforming to ASTM will be permitted. If block is used, a mortar coating shall be applied the same as with masonry construction of manholes.
- B. If noted on Drawings, catch basins shall be constructed with sumps.
- C. Foundations shall be constructed as a cast-in-place concrete slab according to details given on Drawings or precast reinforced concrete base slabs as specified under Manholes.

2.04 MANHOLE STEPS

- A. Manhole steps shall be asphalt-coated cast iron or be steel-reinforced, high-density polypropylene plastic meeting OSHA requirements. They shall be a minimum 10 inches wide and placed a maximum of 16 inches apart.

2.05 FRAMES AND COVERS

- A. Cast iron frames and covers shall be furnished and placed on each manhole by CONTRACTOR. Casting materials shall conform to ASTM A 48, Class 30 or better for gray iron, or ASTM A 536 for ductile iron. Casting shall be free of defects and shall be smooth and well cleaned by shot blasting. Castings shall be of the size and type as called for on Drawings. Lids shall be self-sealing on all sanitary sewer manholes. Castings shall be set flush with sidewalk, pavement, or ground surface and shall be securely cemented in place. In gravel streets, covers shall be set 4 inches below the surface.
- B. Where noted on Drawings, bolted gasketed frames and covers shall be provided. The frames shall be anchored to the concrete manhole sections according to details shown on Drawings.

2.06 PRECAST REINFORCED CONCRETE MANHOLES

- A. Precast manhole base sections, riser sections, conical sections, flat slab tops, grade rings, manhole steps and ladders shall meet the requirements of ASTM C 478.
- B. Premium modified tongue and groove joints with rubber gaskets meeting the requirements of ASTM C 443 shall be provided for all sanitary sewer manholes. Joints in storm sewer, water main, and pumping main manholes shall be either premium joint as specified for sanitary manholes or shall be tongue and groove with a cold-applied plastic joint-sealing compound and primer.
 - 1. The joints around the inside circumference of the manhole shall be pointed with cement mortar. All holes provided for handling and lifting shall be filled with mortar and made watertight.
- C. Foundations for precast manholes shall be constructed as a cast-in-place concrete slab, precast reinforced concrete slab, or precast reinforced concrete base riser section with integral floor as specified under Division 3 and as shown on Drawings. Steel reinforcing for precast base slabs shall meet the requirements of ASTM C 472.
- D. Pipe-to-manhole connections on new sanitary sewers shall be made with resilient connectors meeting the requirements of ASTM C 923 and shall be adequate for hydrostatic pressures of 10 psi, without leakage, when tested in accordance with ASTM C 923 Specifications.

PART 3 - EXECUTION

3.01 DEWATERING

- A. Dewatering of Site shall be as specified under Section 02240.
- B. Subbase preparation is an adequate foundation for all manhole structures and shall be obtained by removal and replacement of unsuitable materials with 4 inches minimum crushed stone, or by such other means as provided for foundation preparation of the connected sewers.

3.02 EXCAVATION AND BACKFILL

- A. Excavation and backfill shall be in accordance with Section 02310.
- B. The excavation shall be of sufficient dimensions to provide ample space for sheeting and bracing where sheeting and bracing are required, and ample space to perform Work in a satisfactory manner.
- C. When the earth at the normal depth of the structure is unsuitable for a foundation for the structure, such unsuitable materials shall be removed as required by ENGINEER and replaced with MDOT Class II material.

3.03 BEDDING

- A. Precast base section shall be placed on a well-graded granular bedding course conforming to the requirements for sewer bedding, but not less than 4 inches in thickness and extending to the limits of the excavation. The bedding course shall be firmly tamped and made smooth and level to ensure uniform contact and support of the precast element.

3.04 PRECAST REINFORCED CONCRETE MANHOLES

- A. All lift holes and all joints between precast elements in manhole shall be thoroughly wetted and then completely filled with mortar, smoothed, and painted both inside and out to ensure watertightness.
- B. Precast sections shall be placed and aligned to provide vertical sides and vertical alignment of the manhole steps. The complete manhole shall be rigid, true to dimensions and watertight.

3.05 PLACING OF CASTINGS, GRADE RINGS, AND TOP SECTIONS

- A. Castings placed on concrete surface shall be set in full mortar beds. The mortar shall be mixed in proportion of 1 part Portland cement to 2 parts sand, by volume, based on dry materials. Castings shall be set accurately to the finished elevation so that no subsequent adjustment will be necessary, or unless otherwise specified by ENGINEER.
- B. Where Work is in paved streets or areas which have been brought to grade, not more than 15 inches shall be provided between the top of the cone or slab and the underside of the manhole casting for adjustment of the casting to street grade.
- C. Where Work is in unpaved streets or alleys, provide not less than 12 inches of adjusting rings between the top of the cone or slab and the underside of the manhole casting for adjustment of the casting to finished grade. Set the top of the manhole casting 5 inches below finished grade, unless otherwise directed by ENGINEER.
- D. Where the last manhole section is a reducing cone and it is set to final grade as required by ENGINEER, if as part of the continuous Work it becomes necessary to lower this casting and the adjustment entails going below the cone, compensation to CONTRACTOR will be allowed for said adjustment and changing of the manhole stacks.
- E. Point up and make watertight adjusting rings used to set the casting to grade.

3.06 CHANNELS AND INVERTS

- A. Channels and inverts shall be made to conform accurately to the sewer characteristics and grades and shall be brought together smoothly with well-rounded junctions.

3.07 PIPE CONNECTIONS

- A. Make pipe-to-manhole connections on sanitary sewers with properly sized watertight resilient connector. Fill other pipe joints firmly full of jointing materials to ensure watertightness. The pipes shall not protrude into the inside face of the manhole, measured along the horizontal center of the pipe unless the pipe is placed through the entire diameter of the manhole.
- B. Use rubber water stops, O-ring gaskets, or poured-in-place pipe sleeves for watertightness between the pipe and manhole. Core drill or star drill new holes in a circle of the required diameter. In no instance shall new holes be sledgehammered out.

3.08 REMOVALS, REPLACEMENTS, AND MODIFICATIONS

- A. Remove existing catch basins where indicated on Drawings or as directed by ENGINEER. Remove frame and cover and deliver to OWNER. Completely break up masonry, or pipe, and remove and dispose. Bulkhead all abandoned pipe connections at both ends where accessible. Backfill the area occupied by existing catch basins after their removal as specified under Section 02315.
- B. Where indicated on Drawings and/or as directed by ENGINEER, fit existing catch basins to be retained with a new frame and cover of the type noted on Drawings including all necessary work required to adjust to grade. Where indicated on Drawings or as directed by ENGINEER, fillet existing sumps with Class C concrete and bulkhead abandoned leads. Work shall be considered incidental to construction of the new catch basin lead.
- C. Where noted on Drawings and/or as directed by ENGINEER, remove existing manhole and/or catch basin castings and replace with a new casting as specified here before.

END OF SECTION

SECTION 02805 - RESTORATION WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Work including the replacement of all permanent type roadway bases and surfaces, concrete sidewalks, curbs and gutters, trees, lawns, and driveways damaged or removed due to the construction of the pipe and appurtenant structures. All such Work shall be in accordance with the Best Modern Practice, OWNER's standards, and/or as specified herein.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 REFERENCES

- A. Michigan Department of Transportation (MDOT):
 - 1. 4.00 Construction Mix Designs.
 - 2. 4.00.04 Trench Surface Conditioning.
 - 3. 4.06 Bituminous Seal Coats.
 - 4. 4.06.06 Bituminous Seal Coats.
 - 5. 4.06.09 Application of Cover Material.
 - 6. 4.06.10 Weather Limitations.
 - 7. 4.06.12 Maintenance of Surface.
 - 8. 6AA Coarse Aggregate.
 - 9. 7.10 Plant Hot Mix Method.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Material Certificates: Provide copies of materials certificates signed by materials producer and CONTRACTOR, certifying that each materials item complies with or exceeds specified requirements.
- B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. Certification: CONTRACTOR shall submit certificates of compliance with applicable MDOT Standard Specifications.

1.05 SITE CONDITIONS

- A. Weather Conditions: Construct asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. Bituminous base course over 2 inches thick may be placed when air temperature is above 35 degrees F (-1 degree C) and rising. Asphalt may not be placed between November 15 and May 5.

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1.06 WARRANTY

- A. Special Warranty: Provide, in accordance with Section 01770, warranties covering the items included under this Section.
 - 1. Warranty Period: 1 year from the time of planting.
 - 2. This warranty includes furnishing new plants as well as labor and materials for installation of replacements. Replacement plantings shall meet or exceed all requirements for original plant materials as specified herein.
 - 3. CONTRACTOR shall not assume responsibility for damages or loss of plants or trees caused by fire, flood, lightning storms, freezing rains, winds over 60 miles per hour, or vandalism.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE

- A. Aggregate base shall be constructed with not less than 12 inches of compacted aggregate placed in two 6-inch layers. Aggregate base shall meet requirements of MDOT Specification for 21A or 22A aggregate. Aggregate base shall extend beyond pavements to match existing aggregate or a minimum of 24 inches.

2.02 AGGREGATE SURFACE

- A. Aggregate surface shall be constructed with not less than 12 inches of aggregate placed in two 6-inch layers. Aggregate surface shall meet MDOT Specification No. 22A.

2.03 BITUMINOUS BASE

- A. Bituminous base shall have a completed thickness of 8 inches, placed and compacted in two 4-inch layers. Bituminous base shall meet the requirements of Bituminous Mixture No. 500-20C of MDOT Specification 7.10. Asphalt cement shall have an asphalt penetration (viscosity) rate of 120-150. A bituminous bond coat meeting MDOT Specification SS-1h or MS-2a shall be applied to each succeeding layer of bituminous material at the rate of 0 - 0.10 gallon per square yard.

2.04 BITUMINOUS PAVEMENT

- A. Bituminous pavement shall be one of the following types:
 - 1. Type A: 1-1/2-inch, No. 1100L-20AA, leveling course over aggregate base with 1-1/4-inch, No. 1100T-20AA, wearing course in trench areas.
 - 2. Type B: 1-1/2-inch, No. 1100L-20AA, leveling course over aggregate base in trench areas with 1-1/2-inch, No. 1100T-20AA, wearing course over entire width of pavement.
 - 3. Type C: 1-1/2-inch, No. 1100T-20AA, wearing course on 8-inch concrete base in trench areas.
 - 4. Type D: 1-1/2-inch, No. 1100T-20AA, wearing course in trench areas over bituminous base course No. 500-20L.
- B. Bituminous mixtures shall be furnished and placed in accordance with MDOT Specification 7.10 with no restriction for the "Aggregate Wear Index."
- C. Asphalt cement shall have an asphalt penetration (viscosity) rate of 120-150. Aggregate required shall be 20AA. When tested at the optimum asphalt content in accordance with ASTM D 1559, the bituminous mixture shall meet the requirements for stability; 1,100 pounds; flow, 8-18 hundredths of

an inch; and voids in mineral aggregate, 15.0 percent, as specified in Table 7.10-1 of MDOT Specifications. The maximum allowable deviations permitted from the approved Job-Mix Formula shall be as shown in Table 7.10-3 of MDOT Specifications.

- D. At CONTRACTOR's expense, a qualified laboratory shall furnish ENGINEER a Job-Mix Formula in accordance with above criteria. After Job-Mix Formula is established, the aggregate gradation and the bitumen content of the bituminous mixture furnished for Work shall be maintained within the uniformity tolerance limits permitted in Table 7.10-3, and within the master gradation range as specified in Table 7.10-2 of MDOT Specifications.

2.05 CONCRETE ROADWAYS

- A. Concrete pavement surfaces shall be replaced with concrete where shown on Drawings. Thickness shall be equal to that removed, but in no cases less than 6 inches.
- B. Concrete for pavements and bases shall be Class P concrete.
- C. Replacement of reinforcing steel shall be similar to that in the existing pavement and shall provide the same cross-sectional area of reinforcement per foot as the existing pavement.

2.06 GRAVEL DRIVEWAYS

- A. Gravel or dirt driveways removed shall be replaced with gravel, and shall be constructed to match existing thickness but with not less than 6 inches of gravel, compacted to 95 percent compaction. Gravel shall meet MDOT Specification No. 22A.

2.07 STONE DRIVEWAYS

- A. Existing stone drive surfaces removed during construction shall be replaced with washed stone, peastone, or limestone, of type and thickness that matches the existing surface. Road gravel (22A) shall not be used to replace stone drives unless authorized by OWNER and ENGINEER.

2.08 BITUMINOUS DRIVEWAYS

- A. All bituminous driveways removed shall be replaced with 1-1/2-inch, 1100L-20AA leveling course and 1-1/4-inch, 1100T-22AA wearing course on a 6-inch-thick compacted gravel base. If the existing driveway has a thicker bituminous cross-section, the difference shall be made up using hot-mix bituminous base as specified under "Bituminous Base."

2.09 CONCRETE DRIVEWAYS

- A. All concrete driveways removed shall be replaced with Class P concrete, 6 inches thick. All driveways replaced shall have welded wire fabric, 6-inch by 6-inch, W1.4 by W1.4, for the full extent of new concrete paving. Joints shall be as specified in concrete work and/or concrete pavements.

2.10 CONCRETE CURB AND GUTTER

- A. Concrete curb and gutter to be replaced shall have the same cross-section as that removed, or as shown on Drawings, using Class P concrete and in accordance with OWNER's standards.

2.11 CONCRETE SIDEWALKS

- A. Concrete sidewalks shall be replaced with walks 4 inches thick (6 inches thick at driveway crossings) and to the same width as the existing walks. Concrete shall be Class B.

2.12 CONCRETE RAMPS

- A. Ramps shall be constructed 6 inches thick and to the width and slope shown on Drawings using Class B concrete. Type of ramp shall be as noted on Drawings for different intersection conditions.

2.13 SEEDING

- A. Seeding shall be one of the following types:
 - 1. Sodded Shoulders, Slope Area, or Flat Field: 4 inches of topsoil, 20 pounds of 10-6-4 commercial fertilizer per 1,000 square feet of area, and 5 pounds of MDOT mixture roadside per 1,000 square feet of area.
 - 2. Flat Lawn Area: 4 inches of topsoil, fertilizer as specified above and 3 pounds of MDOT mixture Class A per 1,000 square feet of area.
- B. Sod: Provide strongly rooted sod, not less than 2 years old, free of weeds and undesirable native grasses, and machine cut to pad thickness of 3/4 inch (plus or minus 1/4-inch), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant). Peat sod will not be acceptable.
 - 1. Provide sod of uniform pad sizes with maximum 5 percent deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10 percent of pad will be rejected.
 - 2. Provide sod composed principally of following:
 - a. Mixed Kentucky Bluegrass (*Poa pratensis*).

2.14 TREE/SHRUB REPLACEMENT

- A. Stakes and Wrap: Trees shall be staked and wrapped. Stakes for guying shall be wood, 2-inch by 2-inch by 30 inches long, minimum size.
- B. Stakes for staking shall be sound, 4-inch-diameter, 9-foot-long cedar posts with bark skinned off for shade trees; 2-inch by 2-inch by 8 feet long for conifers under 5 feet in height.
- C. Staking wire shall be No. 12-gauge galvanized steel.
- D. Hose for covering wire shall be new or used, black or red, 2-ply, fiber-reinforced garden hose, not less than 1/2-inch inside diameter. Seconds rejected by factory are acceptable.
- E. Tree wrap shall be treated wrapping Kraft wrap or approved equal.
- F. Plant Materials:
 - 1. Quality and Size: Plant materials shall be sound, healthy, vigorous, and free from plant diseases and insect pests or their eggs and shall have normal, healthy root systems. All measurements such as spread, ball size, number of canes, quality designation, etc., shall be in accordance with

- the latest edition of AAN USA Standard for nursery stock. Trees shall be calipered 6 inches above the ground.
2. Sources: Must be located in the same or higher hardiness zone as determined by the latest edition of the "Plant Hardiness Zone Map," Agricultural Research Service, U.S. Department of Agriculture.
 3. Plant Material Quality Assurance, Plant Material Selection and Approval Operations: All trees required by this Contract shall be tagged by CONTRACTOR at the source for inspection and approval by ENGINEER in writing at least 2 weeks prior to each desired inspection date. Photographs of materials may be required for preliminary inspection of materials from remote sources.
 4. Root Protection: Trees and shrubs shall be balled and burlapped. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root systems necessary for full recovery of the plant. Balls shall be securely wrapped with burlap and bound with cord. No balled and burlapped plant shall be planted if the ball is cracked or broken.
 5. Protection During and After Delivery: All plant material is to be delivered to Site in closed vehicles or in open vehicles with the entire load properly covered in transit for protection from drying winds. They shall be planted immediately upon delivery. No plant shall be bound with rope or wire in a manner that would damage the bark or break the branches.

PART 3 - EXECUTION

3.01 COORDINATION OF WORK

- A. Type of restoration shall be as noted on Drawings regardless of existing surface.
- B. The placing of base and surface courses shall follow immediately after backfilling the trench so that not more than 600 feet of length of trench shall be incomplete at one time. If areas of trench in excess of 600 feet are left incomplete, CONTRACTOR shall provide such necessary temporary roadway surface as directed by ENGINEER. Any material placed in the trench other than that specified shall be considered as a temporary surface and shall be removed. No payment will be allowed for temporary roadway construction.
- C. All utilities, such as catch basins, manhole castings, water valve boxes, etc., shall be adjusted prior to installation of new pavement so that the finished surface will meet such utilities smoothly when surfacing is completed.

3.02 SAW CUT JOINTS

- A. Damaged areas shall be removed by sawing a straight-cut parallel with longitudinal and transverse construction or contraction joints. No saw cuts shall be nearer than 5 feet to a longitudinal or transverse joint or to the edge of the pavement. If the damaged area is less than 5 feet from an existing joint, the existing surface shall be saw-cut 5 feet from the damaged area, removed, and replaced. If the damaged area is less than 5 feet from the edge of the pavement, the removal and replacement shall be extended to said edge of pavement.
- B. Saw cutting of concrete shall be done with a carborundum saw to a minimum depth of half the slab thickness or that depth required to cut reinforcing steel. Bituminous surfaces shall be cut full depth.
- C. After the trench is backfilled and before the pavement over the trench is replaced, all angular and ragged irregularities on the edges of the cut pavement shall be removed giving a smooth and regular

edge of pavement. Payment for cut joints required shall be included under the unit price of pavement restoration.

3.03 EXCAVATION

- A. Before repaving is started, all trenches and area around structures shall be excavated or backfilled to the level of the subgrade as required by the type of pavement replacement and cross-section specified. All existing pavement that has been undercut by the excavation for the pipe or structures shall be removed. The finished subgrade shall be smoothed, trimmed, and compacted to the required grade and cross-section. Compaction of the finish subgrade shall be obtained by suitable means approved by ENGINEER.

3.04 AGGREGATE BASE

- A. Place aggregate base on a prepared subbase or subgrade in accordance with construction methods described in Section 3.01 of MDOT Specifications.

3.05 AGGREGATE PAVEMENTS

- A. Aggregate surfaces shall be replaced with aggregate. After placing aggregate, this surface shall immediately be opened to traffic and as holes and ruts appear, they shall be filled with aggregate and the surface shall be maintained as a smooth, dust-free street surface until Work is accepted by ENGINEER and OWNER.

3.06 BITUMINOUS BASE

- A. Place bituminous base on a prepared subbase or subgrade in accordance with construction methods described in Division 4 of MDOT Specifications.

3.07 BITUMINOUS PAVEMENTS

- A. Pavement surfaces shall be replaced with bituminous concrete of the type and in locations shown on Drawings. Work shall consist of saw cutting existing surfaces as herein specified under Saw Cut Joints, conditioning and treating the base course with prime or bond material and constructing thereon a bituminous concrete surface consisting of mineral aggregate, mineral filler, and bituminous material combined by a plant hot mix method per MDOT Specification. Construction methods and equipment for placing bituminous materials shall be as specified in MDOT Standard Specifications.
- B. Pavement surfaces shall be replaced to match existing widths but new pavements shall not be less than 22 feet wide.
- C. Conditioning of Base: Bituminous base shall be treated with a bond coat applied at the rate of 0 - 0.10 gallon per square yard. Bond coat shall be SS-1h or MS-2a.
- D. Leveling Course: Bituminous leveling course mixture shall be placed in one or more layers to the cross-section shown on Drawings. When the total application rate exceeds 220 pounds per square yard, the leveling course shall be applied in 2 courses. A bond coat shall be applied at the rate of 0 - 0.10 gallon per square yard between courses.

- E. Wearing Course: Following completion of the leveling course or courses, the surface shall be treated with a bond coat of 0 - 0.10 gallon per square yard. The wearing course mixture shall be placed according to the cross-section shown on Drawings in one or more courses as required.
- F. All joints in the bituminous pavements shall be vertical joints. Where the joints are allowed to set before the adjoining pavement is placed, such joints shall be treated with bond coat material.
- G. Feathering to connect new pavement to an existing pavement will not be allowed.

3.08 CONCRETE CONSTRUCTION

- A. Pavement: The surface of concrete pavements shall be properly consolidated and struck off to such elevations so as to match adjacent pavement and made uniform by transverse floating. As soon as all excess moisture has disappeared, the pavement shall be given a final light brooming finish by dragging a seamless strip of damp burlap or cotton fabric. Edges of all joints shall be tooled.
 - 1. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.
- B. Curb and Gutter: Concrete curb and gutter shall be placed prior to the placement of other types of roadway surfaces including concrete pavements.
 - 1. Curb and gutter to be replaced shall be determined by ENGINEER and shall include any cracked or broken sections and any sections which have settled 0.25 inch or more.
 - 2. Forms shall be complete front and back type. Back forms resulting in hand forming the curb and gutter will not be allowed. Forms shall be of metal, straight and free of distortion and of sufficient strength to resist springing during the placing of concrete. Forms shall be securely staked, braced, and tied to the required line and grade. Flexible steel or adequately sized lumber may be used for short radius forms.
 - 3. One-inch expansion joints shall be placed opposite expansion joints in an abutting pavement. If curb or curb and gutter do not abut a concrete pavement, place expansion joints at all spring lines of street returns. If intersecting streets are more than 300 feet apart, place expansion joints at 200-foot intervals. For MDOT Standard Details A, B, C5, C6, and D curb and gutter, place expansion joints in abutting pavement.
 - 4. If the structure does not abut a concrete pavement or base, contraction joints shall be placed at approximately 100-foot intervals.
 - 5. Intermediate plane of weakness joints shall be placed at approximately 10-foot intervals between other joints as called for above.
 - 6. Curb returns and curb cuts for driveways shall be installed as required.
 - 7. The gutter and top of curb shall not vary more than 3/16 inch in 10 feet when checked with a 10-foot straightedge.
 - 8. After the back forms are removed, honeycomb and minor defects shall be filled with mortar, composed of 1 part Portland cement and 2 parts sand.
 - 9. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.
- C. Sidewalks: Forms shall be of metal or wood, straight and free of distortion, and of sufficient strength to resist springing during the placing of concrete. Forms shall be securely staked, braced, and tied to the required line and grade. Flexible steel or adequately sized lumber may be used for short radius forms.

1. The walk subgrade shall be compacted to 95 percent compaction by tamping. After wetting the subgrade, the concrete shall be placed to the proper depth and spaded along the form faces.
2. Concrete shall be alternately tamped and screeded until all voids are removed and the surface has been brought to the required grade. The surface shall then be floated to produce a smooth, dense surface, free from irregularities. All edges and joints shall be rounded to a radius of 1/4 inch with an edging tool and trowel. As soon as all excess moisture has disappeared, the surface shall be finished by light brooming.
3. Walks shall be divided into blocks approximately square, using slab division forms or by cutting joints after floating. These joints shall be 1/2-inch-deep by 1/8- to 1/4-inch in width, and shall be finished smooth and true to line. Bituminous expansion joints shall be provided at intervals of 50 feet and at junctions with structures and curbs. Control joints shall be located between expansion joints at intervals equal to the sidewalk width.
4. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.

3.09 SEEDING

- A. Wherever the pipe trench passes through an area to be seeded, the backfilling shall be carried up to the surface except the top 4 inches, which shall be selected topsoil preserved or secured elsewhere for this purpose. This topsoil shall be rich, black surface earth, free from sod, weed stalks, or debris. The trench surface shall be carefully raked to an even surface, and all stones, sticks and other debris removed therefrom.
- B. Seeded areas shall receive a proper mulch of chopped straw, jute matting, or woven Kraft paper yarn. Seed shall not be sown between June 15 and August 15, or between October 15 and April 15, or at any time when the soil has insufficient moisture to ensure proper germination, or CONTRACTOR shall provide sufficient application of water by sprinkling until a growing catch of grass is established.

3.10 SODDING

- A. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.
- C. When sod is laid on slopes, the first row of sod shall be laid at the bottom of the slope parallel to it, with subsequent rows laid from bottom to top. On slopes steeper than 3:1, the sod shall be secured with pegs spaced at 2 feet maximum, vertically and horizontally.
- D. Water sod thoroughly with a fine spray immediately after planting.
- E. Sodded areas shall be kept moist for the maintenance period. After the sod is installed, all areas greater than 1 foot which fail to show a uniform stand of grass, shall be resodded.

3.11 RECONDITIONING EXISTING LAWNS

- A. Recondition existing lawn areas damaged by CONTRACTOR's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.
- B. Provide fertilizer, seed or sod, and soil amendments as specified for new lawns, and as required, to provide a satisfactorily reconditioned lawn.
- C. Provide new topsoil, as required, to fill low spots and meet new finish grades.
- D. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.
- E. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from CONTRACTOR's operations, including oil drippings, stone, gravel, and other loose building materials.
- F. Where substantial lawn remains but is thin, mow, rake, aerate if compacted, fill low spots, remove humps, and cultivate soil, fertilize, and seed. Remove weeds before seeding, or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
- G. Water newly planted lawn areas and keep moist until new grass is established.

3.12 TREE/SHRUB REPLACEMENT

- A. Trees noted on Drawing or designated by ENGINEER to be removed shall be replaced with trees of the sizes and types listed on Tree Schedule. OWNER will decide which of the 6 types of trees shall be replaced in each location. All ornamental shrubs in private lawn areas that are damaged must be removed and replaced in kind, with the largest available specimen.
- B. Preparation: Tree pits shall be excavated as shown on Drawings. Subsoil dug from pits, trenches, and beds shall be disposed of by CONTRACTOR.
- C. Topsoil shall be provided in sufficient quantities to be placed:
 - 1. In tree pits, 6 inches in depth below the balled root and 1 foot in width around the ball.
 - 2. In shrub pits, 6 inches in depth below the balled or container root and 6 inches in width around it.
 - 3. All other planting beds shall receive a minimum of 6 inches of topsoil.
- D. Planting: CONTRACTOR is responsible for planting to correct grades and alignment and all plants shall be set so that, when settled, they will bear the same relation to finish grade as they did before being transplanted. No filling will be permitted around trunks or stems.
 - 1. When the plant has been properly set, the pit shall be backfilled with planting mixture, gradually filling, tamping, and settling with water. No soil in a frozen or muddy condition shall be used for backfilling. A ring of soil shall be formed around the edge of each plant to hold water.
 - 2. CONTRACTOR shall make adjustments in the location of plants where necessary as directed by ENGINEER.

- E. Mulching: All planting shall be mulched with a cover of shredded bark mulch.
- F. Watering: All plants shall be thoroughly soaked after planting. After each watering, all beds shall be raked and left in a complete and finished manner.
- G. Pruning and Repair: Upon completion of planting, all trees and shrubs shall have been pruned and injuries repaired. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots from transplanting. Pruning shall be done in such a manner as not to change the natural habit or shape of the plant, as directed by ENGINEER. All cuts shall be made flush, leaving no stubs. Notify ENGINEER at least 1 week prior to pruning operations.
- H. Guying, Staking, and Wrapping Trees: Guying and staking shall be completed immediately after planting. Maintain guys and stakes until the end of the guarantee period. The trunks of all deciduous trees larger than 6 to 8 feet grade shall be wrapped with standard tree wrap from the first branch down to the ground and secured at every second wrap with twine.

3.13 PROTECTION

- A. Protection and Maintenance: CONTRACTOR shall assume responsibility for maintaining CONTRACTOR's Work to the end of the guarantee period. During this period, CONTRACTOR shall make a minimum of 1 maintenance trip every 4 weeks during the growing season, and as many more as necessary to keep the plantings in a thriving condition.
 - 1. Maintenance of plants shall consist of pruning, cultivating, weeding, watering, keeping guying taut and trees erect, raising tree balls which settle below grade, and providing such sprays as are necessary to keep the planting free of insects and diseases.
- B. Acceptance: At the end of the warranty period, final acceptance will be made by ENGINEER and OWNER, provided all requirements of the Specifications have been fulfilled.
 - 1. Inspection of the plantings will be made jointly by CONTRACTOR and ENGINEER at completion of planting. All plants not in a healthy growing condition shall be removed and replaced with plants of like kind, size, and quality as originally specified before close of next planting season.

END OF SECTION

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 REQUIREMENTS

- 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 03200 - Reinforcing Steel
- B. Section 03250 - Concrete Accessories
- C. Section 03290 - Joints in Concrete
- D. Section 03300 - 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. International Building Code
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 301 - Specifications for Structural Concrete for Buildings
 - 4. ACI 347 - Recommended Practice for Concrete Formwork
 - 5. U.S. Product Standard for Concrete Forms, Class I, PS 1
 - 6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 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 neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.
- 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 so as 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 building shall extend beyond the legal boundary of the building.

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 wastewater or enclosed surfaces above the wastewater, 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 so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. 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 achieved 28-day compressive strength, unless approved by Engineer. Additional concrete test cylinders used for shoring removal, as required, shall be cured on site. 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.

Minimum Time Forms are to Remain in Place:

Part of Structure	Average Air Temperature* During Period	
	40 - 50 degrees F	>50 degrees F
Walls, columns and sides of beam (hours)	72	24
Bottom forms for slabs, beams arches not reshored (days)	12	7
Bottom forms for slabs, beams and arches if reshored (days)	7	4

* Air temperature near form.

- 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 be available for inspection at all times 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 in advance 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.

END OF SECTION

SECTION 03200 - REINFORCING STEEL

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.
- B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - 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. International Building Code
 - 2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
 - 3. ACI SP66 - ACI Detailing Manual
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcing
 - 5. ACI 318 - Building Code Requirements for Structural Concrete
 - 6. WRI - Manual of Standard Practice for Welded Wire Fabric
 - 7. ASTM A 185 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcing
 - 8. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.
 - 2. Mill test certificates - 3 copies of each.
 - 3. Description of the reinforcing steel manufacturer's marking pattern.
 - 4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
 - 5. Proposed supports for each type of reinforcing.
 - 6. Request to use splices not shown on the Drawings.

7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.
8. Request for placement of column dowels without the use of templates.
9. Request and procedure to field bend or straighten partially embedded reinforcing.

1.05 QUALITY ASSURANCE

- A. If requested by the ENGINEER, the CONTRACTOR shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests due to material failing initial tests shall be paid by the CONTRACTOR.

PART 2 - PRODUCTS

2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type, and grade.
- B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 185 and the details shown on the Drawings.
- C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The ENGINEER reserves the right to require the CONTRACTOR to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the CONTRACTOR.
- D. Field welding of reinforcing steel will not be allowed.
- E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcing during concrete placement. Slab bolsters shall have gray plastic-coated legs.
- B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

- A. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.
- B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

- C. Hot-forged sleeve type couplers shall not be used. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

2.04 DOWEL ADHESIVE SYSTEM

- A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and reinforcing bar. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. The embedment depth of the bar shall be per manufacturer's recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. Engineer's approval is required for use of this system in locations other than those shown on the Drawings. Fast-set epoxy formulations shall not be acceptable.
- B. Where identified on the Contract Drawings or for installation of concrete where anchorage failure could present a life-threatening hazard, adhesive systems shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories, must comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. Installation of adhesive system shall be per manufacturer's recommendations and as required in Item A above.

PART 3 - EXECUTION

3.01 TEMPERATURE REINFORCING

- A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.004 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0030 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
- B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.
- C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved by the Engineer to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.

D. Welded wire fabric shall be furnished in flat sheets only.

3.03 DELIVERY, STORAGE AND HANDLING

- A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.
- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 PLACING

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.
- B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcing in position, shall be provided by the CONTRACTOR at no additional cost to the OWNER.
- E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.
- F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the ENGINEER.
- G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.

- H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings or authorized in writing by the ENGINEER. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.
- I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations. A representative of the manufacturer must be on site when required by the ENGINEER. At least 25 percent of the dowels installed shall be proof tested to 1.33 times the allowable load specified by the manufacturer, or as indicated on the Drawings. If the dowels are required to have a hook at the end to be embedded in the new work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate the testing.

3.05 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the ENGINEER.
- B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Mechanical splices shall be used only where shown on the drawings or when approved by the ENGINEER.
- E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.06 INSPECTION

- A. The CONTRACTOR shall advise the ENGINEER of intentions to place concrete and shall allow ENGINEER adequate time to inspect all reinforcing steel before concrete is placed.
- B. The CONTRACTOR shall advise the ENGINEER of intentions to place grout in masonry walls and shall allow ENGINEER adequate time to inspect all reinforcing steel before grout is placed.

END OF SECTION

SECTION 03250 - CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, epoxy bonding agent, and concrete anchors.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03290 - Joints in Concrete
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Sealers

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. Federal Specification TT-S-00227 E (3)
 - 2. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 3. ASTM D412 Standard Tests for Rubber Properties in Tension
 - 4. ASTM D 624 Standard Test method for Rubber Property - Tear Resistance
 - 5. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
 - 6. ASTM D1751 Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types)
 - 7. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 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. Retrofit PVC waterstops shall be flat ribbed type with center bulb, 6 inches tall with a minimum thickness at any point of 3/8 inches.
- B. 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.
- C. 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).
- D. 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.
- E. 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. Retrofit Waterstop manufacturer must provide a complete system including all Waterstop, stainless steel anchoring hardware, and epoxy for installation.

2.04 WATERSTOP ADHESIVE

- A. Adhesive between waterstops and existing concrete shall be as recommended by waterstop manufacturer.

2.05 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07900, Joint Sealers.

2.06 EPOXY BONDING AGENT

- A. Epoxy bonding agent shall conform to ASTM C881

2.07 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.

2.08 CONCRETE ANCHORS

A. Adhesive Anchors:

1. 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. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. No “or equal” products will be considered unless prequalified and approved by the Engineer and Owner.

B. Concrete Anchor Materials:

1. Concrete anchors used to anchor structural 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, 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 Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.09 MASONRY ANCHORS

- A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.
- B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts 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 with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer’s installation instructions.
- 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 Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.01 PVC WATERSTOPS

- A. PVC waterstops shall be provided 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 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 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, 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 not 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 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.

3.03 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 contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It 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.

3.04 CONTRACTION JOINT INSERTS

- A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.
- B. For contraction 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 contraction joints as shown on the Drawings.
- D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.
- 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.

3.05 EPOXY BONDING AGENT

- A. The Contractor shall use an epoxy bonding agent for bonding all 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.

3.06 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.

3.07 ANCHOR INSTALLATION

A. Concrete Anchors and Masonry Anchors

1. Overhead adhesive anchors, and base plates or elements they are anchoring, 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. Concrete anchors shall not be used in place of anchor bolts without Engineer's approval.
4. All stainless-steel threads shall be coated with antiseize lubricant.

B. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days.
2. 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.
3. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. No cored holes shall be allowed unless specifically approved by the Engineer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and threaded rod/bolt unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling.

C. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
2. All stainless-steel bolts shall be coated with antiseize lubricant.

END OF SECTION

SECTION 03290 - JOINTS IN CONCRETE

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.
- B. Types of joints in concrete shall be as follows:
 - 1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.
 - 2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.
 - 3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Sealers

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. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Layout drawings showing location and type of all joints to be placed in each structure.
 - 2. Details of proposed joints in each structure.

PART 2 – MATERIALS

2.01 MATERIALS

- A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Sealers.

PART 3 - EXECUTION

3.01 CONSTRUCTION JOINTS

- A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.
- B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25'-0".
- D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.
- E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the ENGINEER. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.
- F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

3.02 EXPANSION JOINTS

- A. Size and location of expansion joints shall be as shown on the Drawings.
- B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

3.03 CONTRACTION JOINTS

- A. Location of contraction joints shall be as shown on the Drawings.
- B. Contraction joints shall be formed with contraction joint inserts as specified in Section 03250, Concrete Accessories.
- C. Sawcutting of contraction joints in lieu of forming will not be allowed unless otherwise noted on the Drawings. Where sawcutting is allowed, joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.

- D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.04 JOINT PREPARATION

- A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air, or light sand blasting.
- C. 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 surface shall present a clean and even appearance.
- D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 REQUIREMENTS

- 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 ordered by the Engineer.
- B. All water holding structures shall be tested for leakage by the CONTRACTOR. The CONTRACTOR shall provide at CONTRACTOR's expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests. Each unit shall be tested separately, and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source other than the discharge from a permitted wastewater treatment facility.
- C. The requirements in this section shall apply to the following types of concrete:
 - 1. Class A1 Concrete: Normal weight structural concrete to be used for interior elevated slabs, basement slabs, exterior walls above grade, interior walls, columns, and beams for non-water containing structures.
 - 2. class B Concrete: Normal weight structural concrete to be used for sidewalks and pavements.
 - 3. Class C Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03200 - Reinforcing Steel
- C. Section 03250 - Concrete Accessories
- D. Section 03290 - Joints in Concrete
- E. Section 03350 - Concrete Finishes
- F. Section 03370 - Concrete Curing
- G. Section 03600 - Grout

1.03 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. 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 | Recommended Practice for Evaluation of Strength Test Results of Concrete |
| 3. | ACI 301 | Specifications for Structural Concrete for Buildings |
| 4. | ACI 304 | Guide for Measuring, Mixing, Transporting, and Placing Concrete |
| 5. | ACI 305 | Hot Weather Concreting |
| 6. | ACI 306 | Cold Weather Concreting |
| 7. | ACI 309 | Recommended Practice for Consolidation of Concrete |
| 8. | ACI 318 | Building Code Requirements for Structural Concrete |
| | | |
| 11. | ASTM C 31 | Standard Methods of Making and Curing Concrete Test Specimens in the Field |
| 12. | ASTM C 33 | Standard Specification for Concrete Aggregates |
| 13. | ASTM C 39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| 14. | ASTM C42 | Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| 15. | ASTM C 88 | Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate |
| 16. | ASTM C 94 | Standard Specification for Ready-Mixed Concrete |
| 17. | ASTM C 114 | Standard Test Method for Chemical Analysis of Hydraulic Cement |
| 18. | ASTM C 136 | Standard Method for Sieve Analysis of Fine and Coarse Aggregate |
| 19. | ASTM C 138 | Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete |
| 20. | ASTM C 143 | Standard Test Method for Slump of Portland Cement Concrete |
| 21. | ASTM C 150 | Standard Specification for Portland Cement |
| 22. | ASTM C 172 | Standard Method of Sampling Fresh Concrete |
| 23. | ASTM C 192 | Standard Method of 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 Recommended Practice for Microscopical Determination of Air-Void Content and Parameters 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 Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete |
| 31. | ASTM C 989 | Standard Specification for Slag Cement for Use in Concrete and Mortars |
| 32. | ASTM C1077 | Recommended Practice for Labs Testing Concrete |
| 33. | ASTM C 1567 | Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |

1.04 SUBMITTALS

A. Product Data

For each manufactured material and product utilized under this section including, but not limited to, aggregates, admixtures, method of adding admixtures, materials and method of curing, method of developing bond at joints, joint materials, waterstops, and vapor barriers.

B. Design Mixes

For each concrete mix indicated.

C. Shop Drawings

Include details of steel reinforcement placement including material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports. Shop drawings to include the proposed construction and control joint locations.

D. Material Certificates

E. Testing agency to perform service required in ACI 301.

F. Laboratory tests on concrete.

G. If ready-mixed concrete is used, provide the following:

1. Physical capacity of mixing plant.
2. Trucking facilities available.
3. Estimated average amount which can be produced and delivered to the site during a normal 8-hour day excluding the output to other customers.
4. Delivery Tickets and Batch Tickets: Furnish to Engineer copies of all delivery tickets and batch tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94.

H. Submit the following in accordance with Section 01330, Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.
2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.
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, aggregate soundness tests, petrographic analysis, mortar bar expansion testing per ASTM C 1567, 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. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.
8. Testing procedures for structures to be leak tested.
9. Testing report upon completion of leak testing. Report shall include test summary, test data and calculations.

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.

- C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a testing laboratory 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 2.02 or 2.03 respectively.
2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:
 - a. For concrete mixed with only Portland Cement, the total alkalis in the cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.40%.
 - b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalis in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%.
3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalis in the cement shall not exceed 1.0%.
4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Blended Cement

1. Blended cements shall be Type IL (Portland Limestone Cement), Type IP (Portland Fly Ash Cement), or Type IS (Portland Slag Cement) conforming to ASTM C 595.
2. Type IP cement shall be an interground 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 interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.
4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.
5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalis in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.2.

- C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the ENGINEER. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

- D. Cement shall be stored in a suitable weather-tight building so as 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.
- 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 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the provisions of Article 2.05.G.2.
- D. For concrete to be used 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 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the provisions of Article 2.05.G.2.
- C. For concrete to be used 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 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.

2.05 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. See section 2.07.C. for max aggregate size for each mix type.
- D. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- E. 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 magnesium sulfate.
- F. Non-reactive aggregates shall meet the following requirements:
 - 1. 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:
 - a) Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.
 - b) Chert or chalcedony, 3.0%, maximum.
 - c) Tridymite or cristobalite, 1.0%, maximum.
 - d) Opal, 0.5%, maximum.
 - e) Natural volcanic glass in volcanic rocks, 3.0%, maximum.
 - 2. 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.
- G. All aggregates shall be considered reactive unless they meet the requirements above for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.
- H. CONTRACTOR shall submit a new trial mix to the ENGINEER for approval whenever a different aggregate or gradation is proposed.

2.06 ADMIXTURES

- A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained, and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall conform 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.
 - 2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site 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.

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, and shall not contain more chloride ions than are present in municipal drinking water. 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.
 4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions.
- C. 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.
- D. 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 by the ENGINEER.
- E. For duct bank concrete add red dye during batching.

2.07 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures, and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used, they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. CONTRACTOR shall submit verification confirming this stipulation has been followed. Field experience records and/or 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.

Concrete Class	Minimum Compressive Strength (28 day)	Concrete Type	Exposure (ACI 318-14)	Maximum water/cement ratio	Air Content	Max. Agg. Size
A2	4,000 psi	Normal Wt.	F0,S0,W0,C0	N/A	3% Max	1"
B	5,000 psi	Normal Wt.	F1,S0,W0,C2	0.40	3% Max	1"
C	3,000 psi	Normal Wt.	F0,S0,W0,C0	0.75	N/A	1"

1. Slump range
 - a. 4" nominal unless high range water reducing admixture is used.
 - b. 3" maximum before addition of high range water reducing admixture.

PART 3 - EXECUTION

3.01 TRIAL MIXES

- A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent testing laboratory designated by the CONTRACTOR and acceptable to the ENGINEER 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 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 PART 2 -- 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. An 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 unit weight (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. _____, Product _____." 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 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 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 before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.
6. Each and 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/cement ratio
 - l. Water, in gallons, actually 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 continuous inspection at the batching plant by the ENGINEER.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ± 0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
2. 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	± 1 percent
b. Water	± 1 percent
c. Aggregates	± 2 percent
d. Admixtures	± 3 percent
3. 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.

4. 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.
5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.
6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. Addition of retarding admixtures shall be completed within 1 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.
13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.03 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 which are subsequently required.
- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. 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 that the design water-cement 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 that meets all specified requirements.
- F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling 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. 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 3.09 of this Section.
- G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as 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 by ENGINEER.
- 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. Concrete shall be placed in all forms in such way as to prevent any segregation.
- I. Placing of concrete shall be so regulated that 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 a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.
- K. When placing concrete which is to 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 so as 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. To achieve this, 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 the area of 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. It 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, however, 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 be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that 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 featheredges, 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 so as 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 waterstops, and/or any proposed deviations from the aforementioned to the ENGINEER for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash 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.

3.04 PLACING FLOOR SLABS ON GRADE

- 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 ENGINEER.
- 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 it shall be raised and maintained above 50°F long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water 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 slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

- E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.
- F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with the requirements of Section 03350 - Concrete Finishes.

3.05 ORDER OF PLACING CONCRETE

- A. In order 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.

3.06 CONCRETE WORK IN COLD WEATHER

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.
- B. In addition to the requirements of ACI 306, concrete placed at any time when air temperature is 40°F or lower 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 the aforementioned 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 in excess of 100°F in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.07 CONCRETE WORK IN HOT WEATHER

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.
- B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the CONTRACTOR and 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 of this Section of the Specifications. All necessary materials and equipment shall be on hand and in position 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 90°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 taken into account. Stockpiled aggregates shall,

if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.

- F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. 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.
- 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.

3.08 QUALITY CONTROL

A. Field Testing of Concrete

- 1. The CONTRACTOR shall coordinate with the OWNER's testing firm 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 provide assistance to the testing laboratory in obtaining samples. The CONTRACTOR shall dispose of and clean up all excess material.
- 3. For every placement of concrete that is 10 cubic yards or less, the following tests shall be performed (as described in paragraphs B through E below):
 - a. Consistency
 - b. Unit Weight
 - c. Air content
 - d. Compressive Strength
 - e. Temperature
- 4. For every placement of concrete that is larger than 10 cubic yards, the following tests shall be performed for every 50 cubic yards (as described in paragraphs B through E below):
 - a. Consistency – test the first truck and one additional truck randomly selected by the OWNER's Resident Project Representative (RPR).
 - b. Unit Weight – test one truck randomly selected by the RPR
 - c. Air content - test the first truck and one additional truck randomly selected by the RPR.
 - d. Compressive Strength - test one truck randomly selected by the RPR
 - e. Temperature - test one truck randomly selected by the RPR
- 5. The sampling of concrete is approved at the truck discharge. If a concrete pump is employed, the CONTRACTOR is advised that 1.5-3.0% air is lost in pumping and such should be accounted for at the point of testing. Therefore, the air content should be adjusted to ensure that the air content meets the specification at the point of placement.
- 6. The first truck is defined as the first truck as accepted by the RPR. The RPR shall have the authority of the OWNER to accept or reject all concrete.
- 7. Sampling is at the discretion of the RPR.
- 8. Additional testing may be required as deemed necessary by the OWNER.

B. Consistency

- 1. The consistency of the concrete will be checked by the OWNER's testing firm by standard slump cone tests. The CONTRACTOR shall make any necessary adjustments in the mix as the OWNER or ENGINEER 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 eventualities.
- 2. Slump tests shall be made in accordance with ASTM C 143.

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. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the OWNER's testing firm in accordance with ASTM C 138.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the OWNER's testing firm in accordance with ASTM C 231.
2. In the event test results are outside the limits specified, additional testing shall occur. Upon discovery of incorrect air entrainment, the concrete shall be removed from the jobsite.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the OWNER's testing firm and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.
2. 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 OWNER's testing firm will fill out the required information on the tag, and the CONTRACTOR shall satisfy themselves that such information shown is correct.
3. The CONTRACTOR shall be required to furnish labor to the OWNER for assisting in preparing test cylinders for testing. 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 specimens 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. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.
4. The CONTRACTOR shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens 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 curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.
5. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

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 all of 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 2.07).
 - b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.

- c. No more than 10% of the compressive tests have strengths greater than the maximum strength specified.
3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, 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.

H. Additional Tests

1. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the CONTRACTOR shall have concrete core specimens obtained and tested from the affected area immediately.
 - a. Three cores shall be taken by the OWNER's testing firm for each sample in which the strength requirements were not met.
 - b. 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.
2. Concrete placed with compressive strengths greater than the maximum strength specified shall be removed and replaced or repaired as deemed necessary by the ENGINEER.

3.09 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. Particular 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 by the ENGINEER.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the ENGINEER. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the ENGINEER.

- 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 by the ENGINEER. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the ENGINEER. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the ENGINEER, unless other means of repair are deemed necessary and approved by the ENGINEER. Extensive repair or replacement will be considered for concrete placed having compressive strengths greater than maximum strength specified. 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 3.10, paragraph F, will be analyzed by the ENGINEER as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular 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 directed by the ENGINEER.

END OF SECTION

SECTION 03350 - CONCRETE FINISHES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03300 - Cast-in-Place Concrete
- C. Section 03600 - Grout

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. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330 - Submittals.
 - 1. Manufacturer's literature on all products specified herein.

PART 2 – PRODUCTS

2.01 CONCRETE FLOOR SEALER

- A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals.

PART 3 - EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

- A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.
 - 1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any

other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities require it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

- A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
 1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a stiff brush or rake prior to final set.
 2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.
 3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.
 4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.
6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.
7. Type "G" Hardened Finish: This finish shall be applied after completion of a Type "B" or Type "C" finish and prior to application of a Type "D" finish. Hardeners shall be applied in strict accordance with the manufacturer's requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type "D" finish shall be applied following completion of application of the hardener.
 - a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.².
 - b. Non-oxidizing heavy-duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.².
8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip shake-on aggregate concurrently with the application of a Type "D" finish. Application procedure shall be in accordance with manufacturer's instructions.
9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of $\pm 1/4$ inch.

3.03 CONCRETE SEALERS

- A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.
- B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.
- C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.
- D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.
- E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

- A. Formed surfaces of equipment pads shall receive a Type III finish.
- B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Exterior exposed concrete walls grout cleaned smooth surface	II
Exterior exposed concrete ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	I
All interior exposed concrete walls and vertical surfaces	I
All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D
All interior finish floors of buildings and structures which are not continuously or intermittently wet	D
Floors of process equipment tanks indicated on Drawings to receive grout topping	F
Garage and storage area floors	G

END OF SECTION

SECTION 03370 - CONCRETE CURING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03300 - Cast-In-Place Concrete
- C. Section 03350 - Concrete Finishes

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. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. ACI 305 - Hot Weather Concreting
 - 4. ACI 306 - Cold Weather Concreting
 - 5. ACI 308 - Standard Practice for Curing Concrete
 - 6. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
 - 7. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. Federal Specification TT-C-800

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Proposed procedures for protection of concrete under wet weather placement conditions.
 - 2. Proposed normal procedures for protection and curing of concrete.
 - 3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
 - 4. Proposed method of measuring concrete surface temperature changes.
 - 5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 - PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

- A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m² when applied at 300 sq.ft./gal. Manufacturer's certification is required.
- B. Where specifically approved by ENGINEER, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Install in strict accordance with manufacturer's requirements.

PART 3 - EXECUTION

3.01 PROTECTION AND CURING

- A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.
- C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.
- D. The CONTRACTOR shall use one of the following methods to ensure that the concrete remains in a moist condition for the minimum period stated above.
 - 1. Ponding or continuous fogging or sprinkling.
 - 2. Application of mats or fabric kept continuously wet.
 - 3. Continuous application of steam (under 150°F).
 - 4. Application of sheet materials conforming to ASTM C171.
 - 5. If approved by the ENGINEER, application of a curing compound in accordance with Article 3.04.
- E. The CONTRACTOR shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.
- F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

- A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

- B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.
- C. The methods of protecting the concrete shall be approved by the ENGINEER and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The CONTRACTOR shall assist the ENGINEER by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the CONTRACTOR in quantity and type which the ENGINEER directs.
- D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.
- E. Protect concrete to provide continuous warm moist curing immediately after placement and during protection period. Minimum protection period is 7 days. Maintain these temperatures:
 - Concrete section <12" during protection period – 55 F
 - Concrete section 12" to 36" during protection period – 50 F
 - Concrete section 36" to 72" during protection period – 45 F

At the end of the protection period, allow concrete to cool gradually to the ambient temperature.

- a. Where temperature of concrete exceeds ambient by 20 degrees Fahrenheit or more, loosen forms and leave in place for at least 24 to 48 hours before removal.
- b. If water curing has been used, maintain concrete temperature for at least 24 hours after water curing is terminated. Allow water-cured concrete to air dry for 72 hrs. before exposure to freezing temperatures.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

- A. When air temperatures exceed 85°F, the CONTRACTOR shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the ENGINEER, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.
- B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.
- C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.
- D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least four (4) additional days using one of the methods listed in paragraph 3.01D.
- E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

- A. Curing compound shall be used only where specifically approved by the ENGINEER. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.
- B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

- A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:
 - 1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.
 - 2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

END OF SECTION

SECTION 03600 - GROUT

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work in accordance with the Contract Documents.

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. CRD-C 621 Corps of Engineers Specification for Non-shrink Grout
 2. ASTM C 109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)
 3. ASTM C 531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing
 4. ASTM C 579 Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing
 5. ASTM C 827 Standard Test Method for Early Volume Change of Cementitious Mixtures
 6. ASTM C 144 Standard Specification for Aggregate for Masonry Mortar
 7. ASTM C 1107 Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01330 - Submittals.
 1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.
 2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

1.04 QUALITY ASSURANCE

- A. Field Tests (required for pump station and storage tank projects)
 1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the ENGINEER to ensure continued compliance with these Specifications. The specimens will be made by the ENGINEER or their representative.
 - a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.
 - b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days and any other time period as appropriate.

2. The cost of all laboratory tests on grout will be borne by the OWNER, but the CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing. The CONTRACTOR shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The CONTRACTOR shall supply all materials necessary for fabricating the test specimens, at no additional cost to the OWNER.
3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the OWNER.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.
2. The minimum compressive strength at 28 days shall be 4,000 psi.
3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.
4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi.

C. Epoxy Grout

1. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Mortar

1. Mortar shall be composed of one part cement or cement with fly ash to 2 parts mortar sand by volume. Add water in an amount not to exceed a water/cement ratio of 0.48.

2.02 CURING MATERIALS

- A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 - EXECUTION

3.01 GENERAL

- A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.
 - 1. Cement grout shall be used for grout toppings and for patching of fresh concrete.
 - 2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing and between the precast culvert sections and the footing.
 - 3. Epoxy grout shall be used for bonding new concrete to hardened concrete.
 - 4. Mortar shall be used to fill the keyway between culvert sections.
- B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.
- C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- D. The CONTRACTOR, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the OWNER.

3.02 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

- A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured from one side only and thence flow across to the open side to avoid air-entrapment.

END OF SECTION

SECTION 03930 - REPAIR EXISTING CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of repair of existing concrete structures shown on Drawings and specified, and includes patching loose, spalled, and unsound concrete, grouting cracks, removing debris resulting from Work, and other Work required to produce a neat and complete job.

1.02 METHODS OF PAYMENT

- A. Repair over 2 Inches Deep: Measure surface area after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the surface areas of each location for repair that are deeper than 2 inches. These measurements shall be done to the nearest 0.1 square foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown, shall be included in a Change Order increasing or decreasing the Contract Price noted on Bid Form.
- B. Repair Equal to or Less than 2 Inches Deep: Measure surface area after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the surface area of each location or fraction of each location for repair that is equal to or less than 2 inches deep. These measurements shall be done to the nearest 0.1 square foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Contract Price noted on Bid Form.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for proprietary materials and items, including patching compounds and others requested by ENGINEER.
 - 2. Samples of materials as requested by ENGINEER, including names, sources, and descriptions.
- B. Material certificates in lieu of laboratory test reports on other materials. Manufacturer and CONTRACTOR shall sign material certificates certifying that each material item complies with, or exceeds, specified requirements.

1.04 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - a. ACI 224, Causes, Evaluation, and Repair of Cracks.
 - b. ACI 201, Chapter 6, "Repair of Concrete."
- B. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at CONTRACTOR's expense.

1.05 PROJECT CONDITIONS

- A. Protect adjacent finish materials against spatter during patching operations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Submit to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cement-Polymer Patching Mortar:
 - a. "EUCO Poly-patch," Euclid Chem. Co.
 - b. "Sikatop," Sika Chem. Corp.
 - c. "Masterpatch 220 EMACO S88," Masterbuilders, Inc.
 - d. "Thin Coat Concrete Coat," Euclid Chem. Co.
 - 2. Moisture-Insensitive Two-Component Epoxy-Resin System:
 - a. "EUCO Epoxy No. 452 LV," Euclid Chem. Corp.
 - b. "Sikadur Hi-Mod LV," Sika Chem. Corp.
 - c. "Concresive Standard LV," Masterbuilders, Inc.

2.02 PATCHING MATERIALS

- A. Patching up to 2-inch Deep: Cement-polymer patching mortar suitable for the particular patching application.
- B. Patching over 2-inches Deep: Class A concrete with the use of any epoxy bonding agent applied at the bonding surfaces, unless otherwise noted.
- C. Grouting of Cracks and Coating of Reinforcement: Moisture-insensitive 2-component epoxy-resin system conforming to ASTM Specification C 881, Type II, Grade 2.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

- A. Existing Concrete or Masonry: Remove unsound material before applying repair. Chip or scarify repair areas to extent necessary to expose sound substrate. Taper edges to leave no square shoulders at perimeter of cavity. Remove loose material from areas being patched.
 - 1. Sandblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper bonding of patch material.
- B. Steel: Clean steel surfaces by abrasive blasting, SSPC SP6, Commercial Blast Cleaning.

3.02 PATCHING

- A. Preparation: Remove all loose, spalled, and unsound concrete by chipping. Cut edges of repair areas to 1/4-inch-deep minimum. Thoroughly clean dirt, oil, dust, or foreign matter from repair surfaces by sandblasting or other approved means.

- B. Rusted Reinforcement: Thoroughly clean by sandblasting all corroded and rusted reinforcement. Wherever a reinforcing bar has lost more than 30 percent of its cross-sectional area, place a new bar of the same size parallel to it using 24-bar diameters lapped length at each end. When a bar has exposed 50 percent or more of its perimeter, chip out the concrete around the bar to provide a minimum of 1-inch gap all around so the bar can be completely encased in new mortar. Immediately following sandblasting, coat all exposed reinforcement with an epoxy-resin system.
- C. Epoxy Bonding Agent: The patching material must be applied within the working time of the bonding agent. Use bonding agent only on surfaces not requiring formwork or when the patching material can be applied within manufacturer's recommended working time.
- D. Mortar Patching: Prepare the cement mortar per manufacturer's recommendations. Apply mortar with a spatula pressed tight against existing surfaces and filling all voids. Build up mortar to original lines in one or more layers, with each layer thickness not to exceed that recommended by the manufacturer, and finished smooth with a steel trowel.
- E. Grouting Cracks: Neat epoxy-resin adhesive shall be pressure-injected into horizontal, vertical, and overhead cracks. Faces of cracks shall first be sealed to prevent leakage.
- F. For pressure-injection grouting, insert one-way valves in clean drilled holes on the face of crack (drill and clean holes before sealing crack faces). Inject adhesive with caulking gun, maintaining slow, steady pressure until crack is filled.
- G. All workers shall have sufficient experience on concrete repair work to be familiar with the use of these materials and methods of operation.
- H. To ensure the quality of the finished work, ENGINEER may require CONTRACTOR to replace workers who, in his judgment, are not capable or qualified to perform this Work. CONTRACTOR, upon receipt of the written notification from ENGINEER, shall immediately comply with this request at no additional cost to OWNER.

3.03 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcing placement and supports.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond to patching material.
- C. Accurately position, support, and secure reinforcement against displacement by construction or patching operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.
- D. Place reinforcement to obtain minimum coverings for reinforcement protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during patching operations. Set wire ties to direct ends into concrete, not toward exposed surfaces.

3.04 SURFACE FINISHES

- A. Patching: Provide finish to match adjacent concrete surfaces unless otherwise noted.

3.05 CURING AND PROTECTION

- A. Protect freshly placed material from premature drying and excessive cold or hot temperatures.
- B. Patching up to 2 Inches Deep: Perform curing as recommended by patching mortar manufacturer.
- C. Patching over 2 Inches Deep: Perform curing of Class A concrete as specified in Section 03310.

3.06 REPAIR OF DEFECTS

- A. Repair patch areas that lack uniformity or have honeycomb, rock pockets, voids over 1/4-inch in diameter, and holes left by tie rods and bolts as specified in Section 03310.

END OF SECTION

SECTION 04200 - UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Concrete unit masonry.

1.02 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f_m):
 - 1. For concrete unit masonry:
 - a. f_m = 2,000 pounds per square inch.
 - b. As indicated on structural Drawings.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Division 1 General Requirements, Shop Drawings covering the items included under this Section. Submittals shall be issued in an electronic format. Comments will be returned in an electronic format.
- B. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.
 - 1. Block data required consists of the following:
 - a. Block grade.
 - b. Block type.
 - c. Weight classification.
 - d. Material test data:
 - 1) Minimum compressive strength.
 - 2) Maximum water absorption (percent).
 - 3) Moisture content percent total absorption.
 - 4) Linear shrinkage percent.
 - e. Material Certificate of Compliance
 - f. Proof of compliance of 30-day curing period.
 - 1) Date of manufacture.
 - 2) Date of shipping.
 - 2. Mortar data required consists of the following:
 - a. Mortar.
 - b. Method of manufacture (proportion or property).
 - c. Material test data:
 - 1) Aggregate for mortar (ASTM C 144 with no exceptions to gradation limits).
 - 2) Mortar composition and properties (ASTM C 780) Proportion Method.
 - 3) Mortar properties (ASTM C 270) Property Method.
 - d. Material Certificate of Compliance.
 - 3. Grout data required consists of the following:
 - a. Grout Mixes: Include description of type and proportion of grout ingredients.
 - b. Material test data: Compressive strength (ASTM C 1019).
 - c. Material Certificate of Compliance.

4. Joint reinforcement, ties, anchors, and flashing:
 - a. Manufacturer's literature.
 - b. Material Certificate of Compliance.

- C. Shop Drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315, Details and Detailing of Concrete Reinforcing, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement. Include special reinforcement required for openings through masonry structures.

- D. Samples for initial selection purposes of the following:
 1. Unit masonry samples in small-scale form showing full extent of colors and textures available for each different exposed masonry unit required.
 - a. Submit a minimum of 18 standard or custom colors for CMU color selection.
 2. Colored masonry mortar samples showing full extent of colors available.

- E. Samples for verification purposes of the following:
 1. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.
 2. Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

- F. Quality Assurance Submittals:
 1. Material certificates shall be signed by manufacturer and CONTRACTOR, certifying that each material complies with requirements.
 2. Material test reports shall be from a qualified independent testing laboratory employed and paid by CONTRACTOR indicating and interpreting test results relative to compliance of the masonry materials with requirements:
 3. Cold weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 4. Hot weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 5. Qualification data for Contractors, firms, and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project name, address, telephone number, names of Engineers and Owners, and other information specified.
 6. Results from tests and inspections performed by OWNER's Representatives shall be reported promptly and in writing to ENGINEER and CONTRACTOR.

1.04 QUALITY ASSURANCE

- A. Mason Qualifications: The masonry foreman responsible for placement of reinforced masonry is required to hold certification for MIM training program for reinforced unit masonry assemblies.

- B. Unit Masonry Standard: Comply with ACI 530.1/ASCE 6, Specifications for Masonry Structures, except as otherwise indicated.

- C. A qualified Professional Engineer must inspect foundations for compliance with dimensional tolerances specified in referenced unit masonry standard, prior to masonry wall construction.
 1. Engineer Qualifications: Professional Engineer legally authorized to practice surveying in jurisdiction where Project is located.

- D. Masonry Contractor Qualifications: The masonry Contractor shall submit in writing 5 projects of similar size and construction type to exhibit the experience level necessary to perform the Work. List project location, size, wall construction type, Owner contact, and telephone number.
- E. Masonry Inspection:
1. A qualified Engineer or Architect must inspect masonry during construction for compliance with the Contract Documents, including conducting the pre-installation conference, inspection of the field-constructed mock-ups, and periodic wall inspection of the critical portions of masonry construction, including flashing, weep hole construction, and proper unit bedding and joint installation techniques for structural integrity and weather-tightness.
 2. Prism Tests: For each type of wall construction indicated, masonry prisms shall be tested per ASTM C 1314.
 3. Grout compressive strength will be tested per ASTM C 1019 for property specification and C 476 for proportion specification.
- F. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- G. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.
- H. Field-Constructed Mock-Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements using materials indicated for final unit of Work:
1. Locate mock-ups on Site in locations indicated, or if not indicated, as directed by ENGINEER.
 - a. Build mock-ups for the following types of masonry in sizes of approximately 8 feet long by 4 feet high by full thickness, including face and backup wythes as well as accessories.
 - b. Each type of exposed unit masonry construction.
 2. Notify ENGINEER 1 week in advance of the dates and times when mock-ups will be erected. Do not proceed with masonry work until mock-up is inspected and accepted. If mock-up is not acceptable, remove mock-up and construct additional mock-ups incorporating corrections until acceptable.
 3. Protect mock-ups from the elements with weather-resistant membrane.
 4. Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.
 - a. When directed, demolish and remove mock-ups from Site.
- I. Pre-installation Conference: Conduct conference at Site to comply with requirements of Division 1 General Requirements.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver masonry materials to Site in undamaged condition.

- B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.
- C. Store cementitious materials off the ground, under cover, and in dry location.
- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each workday. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours, and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and doorframes, as well as similar products with painted and integral finishes from mortar droppings.
- D. Cold Weather Construction:
 - 1. Perform the following construction procedures while Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation, except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 degrees F (6 degrees C).
 - 2. 40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):
 - a. Mortar: Heat mixing water to produce mortar temperature between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Follow normal masonry procedures.
 - 3. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - 4. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):

- a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - c. Heat both sides of walls under construction using salamanders or other heat sources.
 - d. Use windbreaks or enclosures when wind is in excess of 15 miles per hour.
5. 20 degrees F (-7 degrees C) and below:
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - c. Masonry Units: Heat masonry units so that they are above 20 degrees F (-7 degrees C) at the time of laying.
 - d. Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4 degrees C) for 24 hours after laying units.
 6. Do not heat water for mortar and grout to above 160 degrees F (71 degrees C).
 7. Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry temperature ranges apply to anticipated minimum night temperatures.
 8. 40 degrees F (4 degrees C) to 32 degrees F (0 degree C):
 - a. Protect masonry from rain or snow for at least 24 hours by covering with weather-resistant membrane.
 9. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Completely cover masonry with weather-resistant membrane for at least 24 hours.
 10. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):
 - a. Completely cover masonry with weather-resistant insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
 11. 20 degrees F (-7 degrees C) and below:
 - a. Except as otherwise indicated, maintain masonry temperature above 32 degrees F (0 degree C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to 40 degrees F (4 degrees C) for 48 hours.
 12. Do not lay masonry units that are wet or frozen.
 13. Remove masonry damaged by freezing conditions.
- E. Hot Weather Construction: When the ambient air temperature exceeds 100 degrees F or 90 degrees F with a wind velocity greater than 8 miles per hour, do not spread mortar beds more than 4 feet ahead of masonry. Set masonry units within 1 minute of spreading mortar.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Water-Repellent Admixture:
 - a. Dry Block Water-Repellent Block Admixture by W.R. Grace and Co.
 - b. Rheomix Rheopel by Master Builders, Inc.

2. Integral Water-Repellent Admixture:
 - a. Dry-Block Mortar Admixture by W.R. Grace and Co.
3. Joint Reinforcement:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
4. Ties and Anchors:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
5. Metal Flashing:
 - a. "Cheney Flashing (Dovetail)," Cheney Flashing Company, Inc.
 - b. "Cheney Flashing (Sawtooth)," Cheney Flashing Company, Inc.
 - c. "Keystone Three-Way Interlocking Thruwall Flashing," Keystone Flashing Co.
6. Copper Fabric Laminate Flashing:
 - a. "Copper Fabric," Afco Products, Inc.
 - b. "Type FCC-Fabric Covered Copper," Phoenix Building Products.
 - c. "Copper Fabric Flashing," Sandell Manufacturing Co., Inc.
 - d. "York Copper Fabric Flashing," York Manufacturing, Inc.
7. Single-wythe Flashing Unit System:
 - a. "Blok-Flash," Sandell Manufacturing Company, Inc.
8. Mortar Net:
 - a. Hohmann and Barnard, Inc.
9. Plastic Rectangular Weep Hole:
 - a. No. 342 Plastic Weep Hole, Hohmann and Barnard.
 - b. Wire-Bond No. 3603 Clear Rectangular Vent, Masonry Reinforcing Corp. of America.
10. Extruded Polystyrene Board Insulation:
 - a. "Styrofoam Scoreboard," Dow Chemical USA.
 - b. "Foamular 250," Owens Corning.
 - c. "CertiFoam 25 SE," DiversiFoam Products
 - d. "Green Guard SB," Pactiv Corporation.
11. Loose Granular Vermiculite Insulation:
 - a. "Zonolite Masonry Insulation," Grace Construction Products.

2.02 MATERIALS

- A. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.03 CONCRETE MASONRY UNITS

- A. Comply with requirements indicated below applicable to each form of concrete masonry unit required.
 1. Provide 2-core, plain-end units for walls vertically reinforced.
 2. Provide special shapes where indicated and as follows:
 - a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 - b. Bullnose units for outside corners of interior work only unless otherwise indicated.

3. Medium-weight Units: Medium-weight units shall be used for interior walls and interior wythe of exterior walls above grade. Units shall be Grade S, manufactured from medium-weight expanded or sintered blast furnace slag, clay, shale, or slate conforming to ASTM C 90.
 4. Concrete Block: Provide units complying with characteristics indicated below for grade, face size, exposed face and, under each form included, for weight classification.
 5. Normal-weight Units: Normal-weight units shall be used for exterior walls below grade and exterior units of single- and multi-wythe walls above grade. Units shall be Grade N, manufactured from normal weight aggregates conforming to ASTM C 90.
 6. Lightweight Units: Lightweight units shall be used for interior walls and interior wythe of exterior walls above grade. Units shall be Grade S, manufactured from lightweight expanded or sintered blast furnace slag, clay, shale, or slate conforming to ASTM C 90.
 7. Size: Provide concrete masonry units complying with requirements indicated below for size, that are manufactured to specified face dimensions within tolerances specified in the applicable referenced ASTM specification for concrete masonry units.
 - a. Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on Drawings.
 8. Provide Cured Units: Manufacturer must store units outside after manufacture a minimum of 30 days under a covered storage area to protect the units from additional moisture during the curing (drying) process.
 9. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated. Where special finishes are indicated, provide units with exposed faces of the following general description:
 - a. Standard aggregate, split face finish.
 10. Where special patterns are indicated, provide units with exposed faces matching color, texture, and pattern. Integral Water Repellent Admixture: An integral liquid polymer admixture mixed with concrete during production of the CMU which cross-links and becomes permanently locked into the CMU, bond beam, or CMU lintel to provide resistance to water penetration to achieve a Class E rating when tested in accordance with ASTM E 514-74.
- B. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, Grade N, and as follows:
1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:
 - a. 1,900 pounds per square inch.
 2. Weight Classification:
 - a. Normal weight (greater than 125 pounds per cubic foot concrete).

2.04 MORTAR AND GROUT MATERIALS

- A. Mortar and Grout
 1. Compressive Strength: 2,000 pounds per square inch.
- B. Portland Cement: ASTM C 150, Types I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce required mortar color.
- C. Masonry Cement: ASTM C 91:
 1. Not allowed.
- D. Hydrated Lime: ASTM C 207, Type S.

- E. Aggregate for Mortar: ASTM C 144 with the following exceptions:
 - 1. Delete gradation limit waiver as described in Article 4.4.
 - 2. For joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. Colored Mortar Aggregates: Ground marble, granite, or other sound stone, as required to match ENGINEER's sample.
- F. Aggregate for Grout: ASTM C 404.
- G. Integral Water Repellent Admixture for Mortar and Grout: An integral liquid polymer admixture designed specifically for use in a mortar mix, which cross-links and becomes permanently locked into mortar to provide resistance to water penetration to achieve a Class E rating when tested in a wall section in accordance with ASTM E 514-74.
- H. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.
- I. Water: Clean and potable.

2.05 REINFORCING STEEL

- A. Provide reinforcing steel complying with requirements of referenced unit masonry standard and this Article.
- B. Steel Reinforcing Bars: Material and grade as follows:
 - 1. Billet steel complying with ASTM A 615, Deformed bar.
 - 2. Grade 60.
- C. Deformed Reinforcing Wire: ASTM A 496.
- D. Plain Welded Wire Fabric: ASTM A 185.

2.06 JOINT REINFORCEMENT

- A. Provide joint reinforcement complying with requirements of referenced unit masonry standard and this Article, formed from the following:
 - 1. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire, and with ASTM A 153, Class B-2 (1.5 ounces per square foot of wire surface) for zinc coating applied after pre-fabrication into units.
 - a. Application: Exterior and interior walls.
- B. Description: Welded-wire units pre-fabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with pre-fabricated corner and tee units, and complying with requirements indicated below:
 - 1. Wire Diameter for Side Rods: 0.1483 inch (9 gauge).
 - 2. Wire Diameter for Cross Rods: 0.1483 inch (9 gauge).
 - 3. For single-wythe masonry, provide type as follows with single pair of side rods:
 - a. Ladder design with continuous diagonal cross rods spaced not more than 16 inches on center.
 - 4. For multi-wythe masonry provide type as follows:
 - a. Adjustable (two-piece) type; ladder design with perpendicular cross rods spaced not more than 16 inches on center with one side rod for each face shell of backing wythe with

separate ties that extend into facing wythe. Ties have 2 hooks that engage eyes in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have clips to engage a continuous horizontal wire in the facing wythe

- a. Number of Side Rods for Multi-wythe Concrete Masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width, plus one side rod for each wythe of masonry 4 inches or less in nominal width.

2.07 TIES AND ANCHORS

- A. Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this Paragraph.
 1. Zinc Coated (Galvanized) Steel Sheet: Carbon steel with zinc coating complying with ASTM A 525, Coating Designation G90.
 - a. Application: Use for dovetail slots and where indicated.
 2. Hot-Dip Galvanized Carbon Steel Sheet: ASTM A 366, Class 2, or ASTM A 635; hot-dip galvanized after fabrication to comply with ASTM A 153, Class B.
 - a. Application: Use for anchors.
- B. Steel Plates and Bars: ASTM A 36, hot-dip galvanized to comply with ASTM A 123 or ASTM A 153, Class B3, as applicable to size and form indicated.

2.08 BENT WIRE TIES

- A. Individual units pre-fabricated from bent wire to comply with requirements indicated below:
- B. Type for Masonry where Coursing Between Wythes Align: Unit ties bent from one piece of wire.

2.09 RIGID ANCHORS

- A. Provide straps of form and length indicated, fabricated from metal strips of following width and thickness.
 1. 1-1/2 inches wide by 1/4-inch thick.

2.10 MISCELLANEOUS ANCHORS

- A. Unit Type Masonry Inserts in Concrete: Cast iron or malleable iron inserts of type and size indicated.

2.11 EMBEDDED FLASHING MATERIALS

- A. Exposed Sheet Metal Flashing: Fabricate from the following metal, complying with requirements specified in Section 07600 and below.
 1. Stainless Steel: 0.0156 inch (28 gauge) thick.
 2. Fabricate through-wall metal flashings embedded in masonry as follows:
 - a. With ribs formed in dovetail pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep hole drainage.
 3. Fabricate metal expansion joint strips from sheet metal indicated above, formed to shape indicated.
 4. Application: Use where flashing is exposed to exterior and is partly concealed in masonry wall.

2.12 MISCELLANEOUS MASONRY ACCESSORIES

- A. Nonmetallic Expansion Joint Strips: Pre-molded filler strips complying with ASTM D 1056, Type 2 (closed cell), Class A (cellular rubber and rubber-like materials with specific resistance to petroleum base oils), Grade 1 (compression-deflection range of 2-5 pounds per square inch), compressible up to 35 percent, of width and thickness indicated, formulated from the following material:
 - 1. Neoprene.
- B. Mortar Net: Provide mortar net made of high-density polyethylene (HDPE) or nylon stands woven into a 90 percent open-mesh, formed into dovetail shape to break up mortar droppings and prevent mortar damming. Mortar net shall be nonreactive with common building materials, nonabsorbent, shall not support mold or fungus growth, and shall be inedible to insects.
- C. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.13 INSULATION

- A. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV (25 pounds per square inch compressive strength); in manufacturer's standard lengths and widths; thicknesses as indicated.
 - 1. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.14 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2-cup dry measure) and laundry detergent (1/2-cup dry measure) dissolved in 1 gallon of water.

2.15 MORTAR AND GROUT MIXES

- A. Do not add admixtures, including air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification for job-mixed mortar and ASTM C 1142 for ready-mixed mortar, of types indicated below.
 - 1. Limit cementitious materials in mortar to Portland cement.
 - 2. For masonry below grade and in contact with earth, and where indicated, use type indicated below:
 - a. Type S.
 - b. Type M.
 - 3. For reinforced masonry use type indicated below unless otherwise indicated on Drawings:
 - a. Type S.
 - b. Type M.

4. For exterior, above-grade load-bearing and non-load-bearing walls and parapet walls, for interior load-bearing walls, for interior non-load-bearing partitions, and for other applications where another type is not indicated, use type indicated below:
 - a. Type S.
- D. Colored Aggregate Mortar: Produce mortar of color required by use of colored aggregates in combination with selected cementitious materials.
 1. Mix to match ENGINEER's sample.
- E. Grout for Unit Masonry: Comply with ASTM C 476 and referenced unit masonry standard.

2.16 SOURCE QUALITY CONTROL

- A. Concrete Masonry Unit Tests: For each type, class, and grade of concrete masonry unit indicated, units will be tested by qualified independent testing laboratory for strength, absorption, and moisture content per ASTM C 140.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of unit masonry.
- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Deliver anchorage items which are to be embedded in other construction before start of such work. Provide setting diagrams, templates, instructions, and directions as required for installation.
- B. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in Project.
- C. Do not wet concrete masonry units.
- D. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units using units of nominal thickness indicated.
- E. When vertical reinforcement is called for, mortar face shell and web of cores containing grout and reinforcing bars.
- F. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses. Masonry directly above chases or recesses wider than 12 inches shall be supported on lintels.

- G. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.
- H. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.
- I. No masonry shall be supported on wood girders or other form of wood construction.

3.03 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4 inch in 10 feet, or 3/8 inch in a story height not to exceed 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/8 inch in any story or 20 feet maximum, or 1/4 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, 3/8 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in any bay or 20 feet maximum, or 1/2 inch in 40 feet or more. For top surface of bearing walls do not exceed 1/8 inch between adjacent floor elements in 10 feet or 1/16 inch within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plain and related portion of columns, walls, and partitions, do not exceed 3/8 inch in any bay, or 20 feet maximum, or 3/4 inch in 40 feet or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/8 inch or plus 1/8 inch.
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 3/8 inch. Do not exceed head joint thickness indicated by more than plus or minus 1/8 inch.

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for 1/2 running bond or 1/3-unit length for 1/3 running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-In Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 - 3. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING

Lay solid brick-size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

- A. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
- B. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
- C. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

3.06 STRUCTURAL BONDING OF MULTI-WYTHE MASONRY

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.
- B. Corners: Provide interlocking masonry unit bond in each course at corners unless otherwise shown.
 - 1. Provide continuity with horizontal joint reinforcement at corners using pre-fabricated L-units in addition to masonry bonding.
- C. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - 1. Provide individual metal ties.
 - 2. Provide continuity with horizontal joint reinforcement using prefabricated T-units.
- D. Nonbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:
 - 1. Install pressure-relieving joint filler in joint between top of partition and underside of structure above.

3.07 CAVITIES/AIR SPACES

- A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.
- B. Tie exterior wythe to backup with continuous horizontal joint reinforcing.

3.08 CAVITY WALL AND MASONRY CELL INSULATION

- A. On units of plastic insulation, install small pads of adhesive spaced approximately 1'-0" on center both ways on inside face, or attach to inside face with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill all cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.09 HORIZONTAL JOINT REINFORCEMENT

- A. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.
- B. Space continuous horizontal reinforcement as follows:
 - 1. For multi-wythe walls (solid or cavity) where continuous horizontal reinforcement acts as structural bond or tie between wythes, space reinforcement as required by Code but not more than 16 inches on center vertically.
 - 2. Reinforce masonry openings greater than 1'-0" wide with horizontal joint reinforcement placed in 2 horizontal joints approximately 8 inches apart immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.
 - 3. Cut or interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
 - 4. Provide continuity at corners and wall intersections by use of prefabricated L- and T-sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 MOVEMENT (CONTROL AND EXPANSION) JOINTS

- A. Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.
- C. Build flanges of factory-fabricated expansion joint units into masonry.
- D. Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Section 07900.
 - 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.11 LINTELS

- A. Install masonry lintel or steel lintels above all masonry openings per Lintel Schedule on Drawings.

3.12 FLASHING/WEEP HOLES

- A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with mortar.
- C. Install Flashings as follows:
 - 1. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 - 2. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches to form a pan.
 - 3. Turn down sheet metal flashings at exterior face of masonry to form drip.
 - 4. Cut off concealed flashing flush with face of wall after masonry wall construction is completed.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:
 - 1. Form weep holes by keeping one head joint free and clear of mortar as recommended by MIM.
 - 2. Space weep holes 24 inches on center.
 - 3. In all cavities/air spaces, place mortar net to a minimum height equal to height of first course but not less than 2 inches immediately above flashing embedded in the wall as masonry construction progresses to splatter mortar droppings and to maintain drainage.

3.13 INSTALLATION OF REINFORCED UNIT MASONRY AND BOND BEAMS

- A. Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.
- B. Temporary Formwork: Construct formwork and shores to support reinforced masonry elements during construction.
 - 1. Construct formwork to conform to shape, line, and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
- C. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
- D. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- E. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8-inch joints.

- F. Where solid CMU units are shown, lay with full mortar head and bed joints.
- G. Lap all splices in horizontal and vertical reinforcing bars at least 48 bar diameters unless otherwise required by governing Building Code.
- H. Reinforcing bars shall have a minimum clear spacing from inside face of masonry core of a minimum of 1 inch.
- I. Clean reinforcement loose rust, mill scale, earth, ice, or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on Drawings or final Shop Drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- J. Position reinforcing accurately at the spacing indicated. Support secure vertical bars against displacement. Horizontal reinforcing shall be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1 inch (whichever is greater).
- K. Field Adjustments: If it is necessary to move bars to avoid interference with other reinforcing steel, conduits, or embedded items, and bars are moved more than 1 bar diameter or enough to exceed the specified tolerances, ENGINEER shall be notified and the resulting arrangement of bars shall be subject to acceptance.
- L. Walls:
 - 1. Pattern Bond: Lay CMU wall units in 1/2 running bond with vertical joints in each course centered on units in courses above and below unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special shaped units where shown and as required for corners, jambs, sash, control joints, lintels, bond beams, and other special conditions.
 - 2. Maintain vertical continuity of core or cell cavities which are to be reinforced and grouted to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
 - 3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
 - 4. Grout fill cores of block wall 2 courses below each bond beam supporting roof, floor, and other structural members. Place metal lath under lowest block to be grouted to confine grout pour.
 - 5. Install two No. 5 vertical bars on each side of all masonry openings extending from 1 inch below lintel bearing point to 2'-0" below the bottom of the window opening unless otherwise indicated on structural Drawings.
- M. Grouting:
 - 1. Use "Fine Grout" per ASTM C 476 for filling spaces less than 4 inches in one or both horizontal directions.
 - 2. Use "Coarse Grout" per ASTM C 476 for filling 4-inch spaces or larger in both horizontal directions.
 - 3. Grouting Technique: Use low-lift grouting techniques subject to requirements which follow.
- N. Low-Lift Grouting:
 - 1. Provide minimum clear dimension of 2 inches and clear area of 8-square-inch in vertical cores to be grouted.

2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters or 10 feet.
3. Lay CMU to maximum pour height. Do not exceed 5-foot height, or if bond beam occurs below 5-foot height, stop pour at course below bond beam.
4. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than 1 hour. Terminate grout pours 1-1/2 inches below top course of pour.
5. Bond Beams: Stop grout in vertical cells 1-1/2 inches below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

3.14 FIELD QUALITY CONTROL

- A. Testing Frequency: Tests and evaluations listed in this article shall be formed during construction for each 5,000 square feet of wall area or portion thereof.
- B. Prism Test Method: For each type of wall construction indicated, masonry prisms shall be tested per ASTM E 447, Method B, and as follows:
 1. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.
- C. Evaluation of Quality Control Tests: In absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

3.15 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain ENGINEER's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 5.
 - a. Job-mixed detergent solution.
 - b. Proprietary acidic cleaner; apply in compliance with directions of acidic cleaner manufacturer.
 6. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 8-2A applicable to type of stain present on exposed surfaces.

- D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer that ensures unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of structural steel Work is shown on Drawings, including Schedules, notes, and details, to show size and member location and typical connections.
- B. Products Supplied but not Installed under this Section: Anchor bolts for structural steel and anchor bolt templates.

1.02 REFERENCES

- A. Reference Standards:
 - 1. ASTM A 6 General Requirements for Rolled Steel Plates, Shapes, and Sheet Piling, and Bars for Structural Use.
 - 2. ASTM A 27 Steel Castings, Carbon, for General Application.
 - 3. ASTM A 36 Structural Steel.
 - 4. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 5. ASTM A 108 Steel Bars, Carbon, Cold-Finished, Standard Quality.
 - 6. ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 7. ASTM A 143 Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - 8. ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 9. ASTM A 307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 10. ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 11. ASTM A 384 Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - 12. ASTM A 385 Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - 13. ASTM A 490 Heat-Treated, Steel Structural Bolts, 150 ksi (1,035 MPa) Tensile Strength.
 - 14. ASTM A 500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 15. ASTM A 501 Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 16. ASTM A 563 Carbon and Alloy Steel Nuts.
 - 17. ASTM A 588 High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4-inch (100 mm) Thick.
 - 18. ASTM A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.
 - 19. ASTM A 759 Carbon Steel Crane Rails.
 - 20. ASTM A 780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 21. ASTM A 992 Structural Steel Shapes.
 - 22. ASTM C 1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 23. ASTM E 94 Guide for Radiographic Testing.
 - 24. ASTM E 142 Method for Controlling Quality of Radiographic Testing.
 - 25. ASTM E 164 Practice for Ultrasonic Contact Examination of Weldments.
 - 26. ASTM E 165 Practice for Liquid Penetrant Examination.
 - 27. ASTM E 709 Practice for Magnetic Particle Examination.
 - 28. ASTM F 436 Hardened Steel Washers.

- 29. ASTM F 959 Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
- 30. AWS D1.1 Structural Welding Code - Steel.
- 31. AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination.
- 32. DOD-P-21035 Paint, High Zinc Dust Content, Galvanizing Repair.
- 33. MIL-P-26915 Primer Coating, Zinc Dust Pigmented.

1.03 DEFINITIONS

- A. Structural Steel is Work defined in American Institute of Steel Construction (AISC), "Code of Standard Practice."

1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
 1. Building design is Type 2 construction according to AISC Specification for Structural Steel Buildings, Section A2.2.
 2. Members and Connection Design: Details shown are typical; similar details apply to similar conditions, unless otherwise shown. Verify dimensions at Site whenever possible without causing delay in Work.
 3. Connections:
 - a. Connections shall develop main members' full strength and shall use minimum material.
 - b. Connections to main members shall be equivalent to 2 angle AISC Standard connections in most instances. Other members shall have AISC Standard connections.
 - c. In bracing, connections shall develop full member strength, but no fewer than 12,000 pounds force in tension.
 - d. If beam reactions are not shown, each end connection, whether riveted, bolted, or welded, shall develop half total uniform load capacity ($wC/2L$), for simple beams as given in AISC Manual of Steel Construction (Ninth Edition) beam load tables, except where otherwise noted.
 - e. Moment connections for wind forces shall be flange type. Use web connections for gravity shear.
 4. Promptly notify ENGINEER if member design or connections for any area, portion, or structure, are not apparent or understood.

1.05 SUBMITTALS

- A. Shop Drawings: Submit, in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 1. Cut details, connections, camber, holes, and other pertinent data. Denote welds by standard AWS A2.4 symbols, and show each weld's size, length, and type.
 2. Furnish setting drawings, templates, and directions for anchor bolt installation and anchorages installed under this Section.
 3. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 - a. Structural steel (each type): Include certified mill report copies covering chemical and physical properties.
 - b. High-strength bolts, including nuts and washers and direct tension indicators if used.
 - c. Structural steel primer paint.
 - d. Shrinkage-resistant grout.

B. Quality Assurance Submittals:

1. Certificates: Submit certification that welders have satisfactorily passed AWS qualification tests.
 - a. Submit notarized compliance certificates, 1 original and 2 copies, from coating applicator that hot-dip galvanized coating meets or exceeds ASTM A 123 specified requirements or ASTM A 153 (as applicable).

C. Record Drawings: At Project closeout, submit Record Drawings of installed products, in accordance with requirements of Section 01770.

1.06 QUALITY ASSURANCE

A. Codes and Standards: Reference documents following, their commentaries, and standards referenced therein, apply to design, fabrication, and construction practices used to accomplish Work shown on Drawings. Comply with following provisions, except as otherwise shown:

1. AISC, "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Paragraph 4.2.1 of Standard Practice code is hereby modified by deleting following sentence: "This approval constitutes OWNER's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as part of the preparation of these Shop Drawings."
2. AISC "Specification for Structural Steel Buildings," including "Commentary" and Supplements thereto as issued.
3. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts."
4. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
5. ASTM A 6, "General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
6. Research Council on Structural Connections (RCSC), "Specification for Structural Joints using ASTM A 325 Bolts."
7. Factory Mutual Loss Prevention Data Handbook.

B. Qualifications:

1. Qualifications for Welding Processes: Qualify welding processes in accordance with AWS "Standard Qualification Procedure."
2. Welder's Qualifications: Welding shall be done by certified welders qualified according to procedures covered in AWS D1.1., using procedures, materials, and equipment for Work.
 - a. Present evidence that welders to be employed in Work have satisfactorily passed AWS qualification tests.
 - b. If welder requires recertification, retesting is CONTRACTOR's responsibility.
3. Coating Applicator shall specialize in hot-dip galvanizing after fabrication and be approved by manufacturers or fabricators, or company shall follow Quality Assurance Manual of American Galvanizer's Association procedures.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: Follow ASTM A 700, Standard Practice for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.

1. Deliver anchor bolts and anchorage devices embedded in cast-in-place concrete or masonry, in ample time to not delay Work.

- B. Storage and Protection: Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Do not store materials on structure in manner that might cause distortion or damage to members or supporting structures. Repair damaged materials (or structures) or provide new materials to replace damaged materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Nonmetallic, Shrinkage-Resistant Grout:
 - a. "Sure-Grip Grout," Dayton-Superior.
 - b. "Master Flow," Chemrex, Inc.
 - c. "NS Grout," Euclid Chemical Co.
 - d. "Crystex," L&M Construction Chemical Co.
 - e. "Multi-Purpose," Symons.
 - f. "Five Star Grout," U.S. Grout Corp.

2.02 MATERIALS

- A. Metal Surfaces: For fabrications exposed to view, use only materials which are smooth, with surface blemish-free including pitting, rust, and scale seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and surface finish application.
- B. Structural Steel W-Shapes: ASTM A992
- C. Structural Steel Channels, Angles, and Plates: ASTM A36.
- D. Hot Formed Structural Steel Tubing: ASTM A 501.
- E. Cold Formed Structural Steel Tubing: ASTM A 500, Grade B.
- F. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.
 - 1. Finish: Black, except where shown as galvanized.
- G. Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.
- H. Anchor Rods: Unheaded Rods: ASTM A 36.
- I. Bolt Fasteners
 - 1. Headed Bolts, Low Strength:
 - a. ASTM A 307, Grade A, carbon steel bolts and carbon steel nuts.
 - 2. Headed Bolts, High Strength Threaded Fasteners:
 - a. ASTM A 325, Type 1, heavy-hex steel structural bolts and heavy-hex carbon steel nuts, ASTM A 563.

- b. Direct tension indicators or washers, ASTM F 959 may be used at CONTRACTOR's option.
 - 1) May use on high-strength bolted connections.
 - 2) Shall use on slip-critical connections.
 - 3. Hardened Steel Washers: ASTM F 436.
- J. Electrodes for Welding: E70XX complying with AWS Code, D1.1.
- K. Structural Steel Primer Paint: Universal rust-inhibiting primer which can accept epoxy, epoxy esters, and phenolic paints as finish coats.
- L. Non-metallic, Shrinkage-Resistant Grout: Pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water reducing agents, complying with ASTM C 1107.

2.03 FABRICATION

- A. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate for delivery sequence which expedites erection and minimizes material handling in field.
- B. Structural steel items built into or anchored into masonry or concrete shall be completely fabricated and shall be furnished with bolts, anchors, clips, and stud anchors to engage with adjacent construction.
- C. Fabricate structural steel items in accordance with AISC Specifications and details shown on reviewed and stamped final Shop Drawings.
- D. Camber structural members to deflection shown or specified.
- E. Unless otherwise noted:
 - 1. Minimum weld size shall be 3/16 inch.
 - 2. Minimum bolt diameter shall be 3/4 inch.
 - 3. Minimum plate thickness shall be 1/4 inch.
 - 4. Minimum Connecting angle shall be 1/4-inch thick.
- F. Shop Assembly:
 - 1. Properly mark and match-mark materials for field assembly.
 - 2. Where finishing is required, complete assembly, including unit welding, before starting finishing operations.
 - 3. Shop Connections: Weld or bolt shop connections as shown.
 - 4. Install non-high-strength bolts, except where high-strength bolts are shown.
 - 5. Bolt field connections, except where welded connections or other connections are shown.
 - 6. High Strength Bolted Construction: Install and tighten high strength, threaded fasteners using ASTM A 325 according to RCSC Specification where high-strength bolts are shown or detailed.
 - 7. Holes: Cut, drill, or punch holes perpendicular to metal surfaces. (Drill holes in bearing plates.) Do not flame-cut holes or enlarge holes by burning.
 - a. Holes for other Work: Provide holes for securing other Work to structural steel framing, and for passing other Work through steel framing members, as shown on Shop Drawings.
 - 8. Welded Construction: Comply with AWS Code for procedures, appearance and weld quality, and methods used in correcting welding Work. Connections exposed after installation shall be

continuously welded. Weld continuously along entire contact area except where tack welding is shown.

- a. Assemble and weld built-up sections by methods which produce true axis alignment without warp.
9. Welded Door Frames: Build up welded doorframes attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug weld steel bar stops to frames, except where shown removable. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches o.c., unless otherwise shown.
 - a. Weld threaded nuts to framing and other specialty items to receive other Work as shown on Drawings.

2.04 FINISHES

- A. Surface Preparation: After inspection and before shipping, clean steel Work to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) procedures as follows:
 1. SSPC-SP10, "Near-White Blast Cleaning."
- B. Shop Priming: Shop prime structural steel, except those members or portions listed below.
- C. Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions at rates that provide not less than 1.5 mils dry film thickness.
 1. Prime embedded steel which is partially exposed on exposed portions.
 2. Do not prime initial 2 inches of embedded areas.
 3. Do not prime surfaces which are to be welded or high strength bolted with friction-type connections.
 4. Do not prime surfaces which are scheduled to receive sprayed-on fireproofing.
 5. Apply 2 coats of paint to surfaces which are inaccessible after assembly or erection. Change second coat color to distinguish it from first.
- D. Galvanizing:
 1. Surface Preparation: Pre-clean steel Work using alkaline cleaner, acid pickle, and flux. Alternatively, blast clean and flux steel.
 2. Application of Coating: Galvanize steel members, fabrications, and assemblies after fabrication by hot-dip process in accordance with ASTM A 123.
 3. Galvanize bolts, nuts, and washers and iron and steel hardware components in accordance with ASTM A 153.
 4. Safeguard products against steel embrittlement in conformance with ASTM A 143.
 5. Handle galvanized articles in manner to avoid mechanical damage and to minimize distortion.
 6. Coating Requirements: Coating Weight: Conform to Paragraph 5.1, ASTM A 123, or Table 1, ASTM A 153.
 7. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from defects detrimental to coated article's stated end use.
 8. Adhesion: Withstand normal handling consistent with coating nature and thickness and normal article use.
- E. Shop Painting: Use painting methods which result in full coverage of joints, corners, edges, and exposed surfaces.

- F. Post-Galvanizing Treatments: Comply with Section 09900 for shop priming and painting.
 - 1. Prepare galvanized metal surfaces to be field painted in accordance with paint manufacturer's recommendations.
 - 2. Shop-coat galvanized metal surfaces with approved primers for galvanized or other approved coatings.

2.05 SOURCE QUALITY CONTROL

- A. Tests, Inspection: Provide access for testing agency to places where structural steel Work is being fabricated or produced so that required inspection and testing can be accomplished.
 - 1. Testing agency may inspect structural steel at plant before shipment; however, ENGINEER reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean bearing surfaces and other surfaces which shall be in permanent contact before assembly.
 - 1. Clean bond-reducing materials from concrete and masonry bearing surfaces and roughen to improve bond to surfaces. Clean base and bearing plates' bottom surface.
- B. Protection:
 - 1. Provide temporary shores, guys, and bracing members with sufficiently strong connections to bear imposed loads during erection, and to keep structural steel secure, plumb, and in alignment against temporary construction loads.
 - 2. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment as erection proceeds.

3.02 ERECTION

- A. Setting Bases and Bearing Plates:
 - 1. Set loose and attached base plates and bearing plates for structural members on wedges, shims, or adjusting nuts or other adjusting devices.
 - 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with base edge or bearing plate before packing with grout.
 - 3. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - a. For proprietary grout materials, comply with manufacturer's instructions.
- B. Site Tolerances: Establish required leveling and plumbing measurements on mean operating temperature of structure. Level and plumb individual structure members within specified AISC tolerances.
 - 1. Set structural steel accurately in locations and to lines and elevations shown. Comply with AISC Specifications for bearing, temporary connections, alignment, and paint removal on surfaces.
 - 2. Splice members only where shown and accepted on Shop Drawings.

3. Align and adjust various members forming complete frame elements or structure(s) before permanently fastening.
- C. Field Connections: Only light drifting shall be permitted to draw parts together. Drifting to match unfit holes shall not be permitted. Do not enlarge unfit holes in members by burning. Hole enlargements essential to make connections shall be done by reaming and twist drills and using proper size bolts. Do not enlarge unfit holes in members by use of drift pins except in secondary bracing members.
 - D. Field Welding: Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds. On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces. Leave finish surfaces of members exposed in final structure free of markings, burrs, and other defects
 - E. Field Bolting: Install and tighten non-high-strength bolts, except where high-strength bolts are shown.
 - F. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting is permitted only on secondary members which are not under stress. (When authorized, finish gas-cut sections equal to sheared appearances.)

3.03 FIELD QUALITY CONTROL

- A. Engage independent testing and inspection agencies to inspect high-strength bolted connections, welded connections, to make tests and prepare test reports.
 1. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
 2. Provide access for testing agency to places where structural steel Work is being assembled so that required inspection and testing can be accomplished.
- B. High-Strength Field-Bolted Connections shall be tested and inspected according to RCSC's "Specification of Structural Joints Using ASTM A 325 Bolts." Direct Tension indicator gaps shall be verified to comply with ASTM F 959, Table 2.
- C. Field Welding: Inspect and test during erection of structural steel as follows:
 1. Certify welders and conduct inspections and tests. Record types and locations of defects found in Work. Record work required and performed to correct deficiencies.
 2. Perform visual inspection of all welds.
 3. Perform tests of welds as follows:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable.
 - c. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 - d. Ultrasonic Inspection: ASTM E 164.
- D. Correct deficiencies in structural steel Work which inspections and laboratory test reports show as not in compliance with requirements. Carry out additional tests, at CONTRACTOR's expense, to reconfirm any original Work non-compliance and to show corrected Work compliance.

3.04 ADJUSTING

- A. Errors in shop or field Work which prevents proper assembling and parts fitting by moderate drift pin use, or moderate reaming and slight clipping, shall be corrected at CONTRACTOR's expense.

3.05 CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas.
 - 1. Apply same paint to exposed areas using same material as used for final painting.
 - 2. Apply touch-up paint by brush or spray to provide 1.5 mils dry film thickness, minimum.
- B. Remove temporary shoring, members, guys, bracing, and connections when permanent members are in place and final connections made and tested.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION

SECTION 05521 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Aluminum pipe and tube handrails and railing systems.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. In engineering handrail and railing systems to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Aluminum: AA Specifications for Aluminum Structures: Fabricate all pipe railings and handrails from 1 1/2 inch aluminum pipe using not less than Schedule 40 for all rails and Schedule 80 for all posts. Posts and handrail brackets shall not be spaced over 5 feet apart unless specifically called for otherwise.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Drawings showing fabrication and installation of handrails and railings, including plans, elevations, sections, details of components, and attachments to other units of Work.
 - 2. Where installed products are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by a qualified Professional Engineer, licensed in the state of Michigan, responsible for their preparation.
 - 3. Product Data for each type of product specified.
 - 4. Samples for verification purposes of each type of exposed finish required, prepared on components indicated below that are of the same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.
 - a. 6-inch-long sections of each distinctly different linear railing member including handrails, top rails, posts, balusters, and ladder rungs.
 - b. Fittings and brackets.
 - c. Welded connections.
- B. Product Test Reports:
 - 1. Based on tests performed by qualified independent testing laboratory evidencing compliance of railing components and systems with requirements based on comprehensive testing of current products.

C. Quality Assurance Submittals:

1. Qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Engineers and Owners, plus other information specified.

1.05 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain handrails and railing systems of each type and material from a single manufacturer.
- B. Engineering Responsibility: Engineer handrails and railing systems by qualified Professional Engineer legally authorized to practice in jurisdiction where Project is located.

1.06 STORAGE

- A. Store handrails and railing systems in clean, dry location, away from uncured concrete and masonry, protected against damage of any kind. Cover with waterproof paper, tarpaulin, or polyethylene sheeting; allow for air circulation inside the covering.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Where handrails and railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
 1. Where field measurements cannot be made without delaying Work, warranty dimensions and proceed with fabrication of products without field measurements. Coordinate other construction to ensure that actual dimensions correspond to warranted dimensions.

1.08 SEQUENCING AND SCHEDULING

- A. Sequence and coordinate installation of wall handrails as follows:
 1. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.
 2. Mount handrails only on gypsum board assemblies reinforced to receive anchors and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Aluminum Pipe and Tube Railing Systems:
 - a. Blum, Julius Blum and Co., Inc.
 - b. Braun, J.G. Braun Co.
 - c. CraneVeyor Corp.
 - d. Moultrie Manufacturing Co.
 - e. Newman Bros., Inc.
 - f. Sterling Factories, Inc.

- g. Superior Aluminum Products, Inc.
- h. Wagner, R&B Wagner, Inc.
- 2. Nonshrink, Nonmetallic Grouts:
 - a. "Bonsal Construction Grout," W.R. Bonsal Co.
 - b. "Kemset," Chem-Masters Corp.
 - c. "Diamond-Crete Grout," Concrete Service Materials Co.
 - d. "Sure-Grip High-Performance Grout," Dayton Superior Corp.
 - e. "Crystex," L&M Construction Chemicals, Inc.
 - f. "Vibropruf No. 11," Lambert Corp.
 - g. "Masterflow 713," Master Builders.
 - h. "Sealtight 588 Grout," W.R. Meadows, Inc.
 - i. "SonogROUT," Sonneborn Building Products Division, ChemRex, Inc.
 - j. "Stoncrete NM1," Stonhard, Inc.
 - k. "Five Star Grout," U.S. Grout Corp.
- 3. Erosion-Resistant Anchoring Cement:
 - a. "Super Por-Rok," Minwax Construction Products Division.

2.02 METALS

- A. Provide metal forms and types that comply with requirements of referenced standards and that are free from surface blemishes where exposed to view in the finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.
- B. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required:
 - 1. Extruded Bar and Tube: ASTM B 221, Alloy 6063T5/T52.
 - 2. Extruded Structural Pipe and Tube: ASTM B 429, 6063-T5/T52.
 - 3. Drawn Seamless Tube: ASTM B 210, 6063-T832.
 - 4. Plate and Sheet: ASTM B 209, 6061-T6.
 - 5. Die and Hand Forgings: ASTM B 247, 6061-T6.
 - 6. Castings: ASTM B 26, A356-T6.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

2.03 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Pre-mixed, factory packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this Section.
- B. Interior Anchoring Cement: Factory pre-packaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at Site to create pourable anchoring, patching, and grouting compound. Use for interior applications only.
- C. Erosion Resistant Anchoring Cement: Factory pre-packaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at Site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water

exposure without need for protection by a sealer or waterproof coating and is recommended for exterior use by manufacturer.

2.04 WELDING MATERIALS, FASTENERS, AND ANCHORS

- A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Fasteners for Anchoring Railings to other Construction: Select fasteners of the type, grade, and class required to produce connections that are suitable for anchoring railing to other types of construction indicated and capable of withstanding design loadings.
- C. Fasteners for Interconnecting Railing Components: Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnection of handrail and railing components and for their attachment to other work, except where exposed fasteners are unavoidable or are the standard fastening method for handrail and railing system indicated.
 - 2. For aluminum railings provide fasteners fabricated from Type 304 stainless steel.
- D. Cast-In-Place and Post-Installed Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, load imposed within a safety factor of 4 as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.
 - 1. Cast-in-place anchors.
 - 2. Chemical anchors.
 - 3. Expansion anchors.

2.05 FABRICATION

- A. Pre-assemble railing systems in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Welded Connections for steel and stainless steel: Fabricate railing systems and handrails for connection of members by welding. For connections made during fabrication, weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined and weld all around.
 - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- C. Welded Connections for Aluminum Pipe: Fabricate pipe handrails and railing systems for connection of members by concealed internal welds, which eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

- D. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- E. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Cut, reinforce, drill, and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.
- G. For handrails and railing systems that are exposed to exterior or to moisture from condensation or other sources, provide weepholes or other means for evacuation of entrapped water in hollow sections of railing members.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water.
- I. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- J. Toe Boards: Provide toe boards at railings around openings and at the edge of open-sided floors and platforms unless otherwise indicated. Fabricate to dimensions and details indicated for connection to, and centered between, each railing post.
- K. Fillers: Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses to produce adequate bearing to prevent bracket rotation and overstressing of substrate.

2.06 FINISHES

- A. Comply with NAAMM Metal Finishes Manual for recommendations relative to application and designations of finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by application of strippable, temporary protective covering prior to shipment.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are not acceptable if they are within 1/2 of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved samples and they are assembled or installed to minimize contrast.
- D. Aluminum Finishes:
 1. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
 2. Mechanical Finish: AA-M12 (Mechanical Finish: as fabricated, nonspecular).
 3. Class I Clear Anodized Finish: AA-M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil) complying with AAMA 607.1.

- E. Galvanized Finish:
1. Hot-dip galvanize items indicated to be galvanized to comply with applicable standard listed below:
 - a. ASTM A 153 for galvanizing iron and steel hardware.
 - b. ASTM A 123 for galvanizing iron and steel products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips.
 2. For exterior steel railings and handrails formed from steel pipe with galvanized finish, galvanize fittings, brackets, fasteners, sleeves, and other ferrous components.
 3. For interior steel railings and handrails formed from steel pipe with galvanized finish, galvanize fittings, brackets, fasteners, sleeves, and other ferrous components.
 4. For interior steel railings formed from steel pipe with black finish, provide nongalvanized ferrous metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
 5. Factory-Primed Finish: Apply air-dried primer immediately following cleaning and pre-treatment, to provide a minimum dry film thickness of 2.0 mils per applied coat, to surfaces that will be exposed after assembly and installation and to concealed, nongalvanized surfaces.
- F. Steel Finishes:
1. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - a. Exteriors (SSPC Zone 1B): SSPC-SP6, "Commercial Blast Cleaning."
 - b. Interiors (SSPC Zone 1A): SSPC-SP7, "Brush-Off Blast Cleaning."
 2. Apply shop primer to uncoated surfaces of handrails and railing components, except those with galvanized finish or to be embedded in concrete or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA1, Paint Application Specification No. 1, for shop painting.
 3. Shop Primer: Manufacturer's or fabricator's standard, fast curing, lead-free universal primer, selected for resistance to normal atmospheric corrosion, compatibility with substrate and field-applied finish paint system indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
 - a. Stripe paint all edges, corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete as masonry construction. Coordinate delivery of such items to Site.

3.02 INSTALLATION

- A. Fit exposed connections accurately together to form tight, hairline joints.

- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of handrails and railings. Set handrails and railings accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of handrails and railing components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/4 inch in 12 feet.
 - 3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- D. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.
- E. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing handrails and railings to in-place construction.

3.03 ANCHORING POSTS

- A. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not less than that required by design loadings.
- B. Anchor posts to concrete with circular or rectangular flanges, floor or wall type, as required by conditions, connected to posts and secured to concrete with expansion anchors.

3.04 RAILING CONNECTIONS

- A. Expansion Joints: Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches of post.

3.05 ANCHORING RAIL ENDS

- A. Anchor rail ends into concrete and masonry with round flanges connected to rail ends and anchored into wall construction with post-installed anchors and bolts.
- B. Anchor rail ends to metal surfaces with oval or round flanges.
 - 1. Connect flanges to rail ends using nonwelded connections.
 - 2. Bolt flanges to metal surfaces.
- C. Install removable railing sections where indicated in slip-fit sockets of same material surface mounted to concrete. Accurately locate sockets to match post spacing.

- D. Anchor posts to metal surfaces with oval flanges, angle type or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
 - 2. For stainless steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
 - 3. For aluminum pipe railings, attach posts as indicated using manufacturer's standard fittings designed and engineered for this purpose.

3.06 ADJUSTING AND CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.
- B. Touch-Up Painting: Cleaning and touch-up painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 of these specifications.
- C. For galvanized surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

3.07 PROTECTION

- A. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.
- B. Clean the following metals by washing thoroughly with clean water and soap, following by rinsing with clean water.
 - 1. Aluminum.
 - 2. Stainless steel.

END OF SECTION

SECTION 06100 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Rough carpentry for the following:
 - 1. Wood grounds, nailers, and blocking.
 - 2. Plywood backing panels.
- B. Drawing and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to this Section.

1.02 DEFINITIONS

- A. Rough carpentry includes carpentry work not specified as part of other Sections and which is generally not exposed, except as otherwise indicated.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Division 01, General Requirements, Submittal Procedures, Shop Drawings covering the items included under Section. Shop Drawing submittals shall include:
 - 1. Product Data: Manufacturer's specifications and installation instructions for materials listed below:
 - 2. Wood Treatment Data: Chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material.
 - 3. Preservative Treatment: For each type specified, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and conformance with applicable standards.
 - 4. For water-borne treatment, include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Site.
 - 5. Fire-Retardant Treatment: Certification by treating plant that treated material complies with specified standard and other requirements.

1.04 PRODUCT HANDLING

- A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

1.05 PROJECT CONDITIONS

- A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other Work.

PART 2 - PRODUCTS

2.01 LUMBER

- A. Lumber Standards: Manufacture lumber to comply with PS 20, American Softwood Lumber Standard, and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
- B. Inspection Agencies: Inspection agencies and the abbreviations used to reference with lumber grades and species include the following:
 - 1. SPIB - Southern Pine Inspection Bureau.
 - 2. WCLIB - West Coast Lumber Inspection Bureau.
 - 3. WWPA - Western Wood Products Association.
- C. Grade Stamps: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20 for moisture content specified for each use.
 - 1. Provide dressed lumber, S4S, unless otherwise indicated.
 - 2. Provide lumber with 15 percent maximum moisture content at time of dressing and shipment for Sizes 2 inches or less in nominal thickness, unless otherwise indicated.

2.02 BOARDS

- A. Exposed Boards: Where boards will be exposed in the finished work, provide the following:
 - 1. Moisture Content: 15 percent maximum, "MC-15."
 - 2. Where transparent or natural finish or no finish is indicated, provide Redwood, Select Heart Grade (RIS).
 - 3. Where painted finish is indicated, provide No. 1 Boards per SPIB rules, Select Merchantable Boards per WCLIB rules, or No. 2 Common Boards and Better per WWPA rules.

2.03 MISCELLANEOUS UNTREATED LUMBER

- A. Provide wood for support or attachment of other Work including bucks, nailers, blocking, furring, grounds, stripping, cants, rooftop equipment bases and support curbs, and similar members. Provide lumber of sizes indicated, worked into shapes shown, and as follows:
 - 1. Moisture content: 15 percent maximum.
 - 2. Grade: Standard grade, light framing size lumber of any species or board size lumber as required. No. 2 Common or Standard grade boards per WCLIB or WWPA rules or No. 2 boards per SPIB rules.

2.04 TREATED LUMBER

- A. Rooftop Equipment Curbs, cant strips, support bases, and wood which will come in contact with water or concrete shall be No. 2, Grade dense or better, Southern Yellow Pine or Douglas Fir, moisture content of 15 percent maximum. All of the above shall be treated as specified under wood treatment for termite and decay protection.

2.05 CONSTRUCTION PANELS

- A. Standards: Comply with PS 1 U.S. Product Standard for Construction and Industrial Plywood for plywood panels and, for products not manufactured under PS 1 provisions, with APA Performance Standard and Policies for Structural-Use Panels, Form No. E445.
- B. Trademark: Factory-mark each construction panel with APA trademark evidencing compliance with grade requirements.
- C. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire retardant treated-plywood panels with grade designation, APA C-D PLUGGED INT, with exterior glue, in thickness indicated or, if not otherwise indicated, not less than 15/32 inch.

2.06 MISCELLANEOUS MATERIALS

- A. Fasteners and Anchorages: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers, and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommended nails.

2.07 WOOD TREATMENT BY PRESSURE PROCESS

- A. Preservative Treatment: Where lumber or plywood is indicated as "Trt-Wd" or "Treated," or is specified herein to be treated, comply with applicable requirements of AWWA Standards C2 (Lumber) and C9 (Plywood) and of AWPB Standards listed below. Mark each treated item with the AWPB Quality Mark requirements.
 - 1. Pressure-treat aboveground items with water-borne preservatives to comply with AWPB LP-2. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 15 percent. Treat indicated items and the following:
- B. Fire-Retardant Treatment: Where fire-retardant-treated wood ("FRTW") is indicated, pressure impregnate lumber with fire-retardant chemicals to comply with AWWA C20 for treatment type indicated below; identify "FRTW" lumber with appropriate classification marking of Underwriters Laboratories, Inc., U.S. Testing, Timber Products Inspection, or other testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Interior Type A: Use where "FRTW" wood is indicated for interior applications.
 - 2. Exterior Type: Use where "FRTW" wood is indicated for exterior, exposed applications.
 - 3. Inspect each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
- B. Set carpentry work to required levels and lines, with members plumb and true to line and cut and fitted.

- C. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. CABO NER-272 for power driven fasteners.
 - 2. Published requirements of metal framing anchor manufacturer.
 - 3. Table 2304.9.1, "Fastening Schedule," in the Michigan Building Code.
- D. Countersink nail heads on exposed carpentry work and fill holes.
- E. Use common wire nails except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drill as required.
- F. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

3.02 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

- A. Provide wherever shown and where required for screening or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.03 INSTALLATION OF CONSTRUCTION PANELS

- A. Comply with applicable recommendations contained in Form No. E 30K, APA Design/Construction Guide - Residential and Commercial, for types of plywood products and applications indicated.
 - 1. Comply with "Code Plus" provisions in above-referenced guide.

3.04 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06610 - FRP FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. FRP structural shapes.
 - 2. FRP stairs and treads.
 - 3. FRP gratings, decking, and frames.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Definitions in ASTM E 985 for railing related terms apply to this Section.
- B. Pultrusion: Process of pulling fiberglass rovings (strands), mats, and other forms of reinforcements such as woven fiberglass through baths of thermosetting liquid resin, and then through a heated forming die (made of steel) to form a completed composite fiberglass structural shape.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design, engineer, fabricate, and install the following FRP fabrications to withstand the following structural loads and loads noted on the design drawings without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each FRP fabrication. Limit deflection to L/200.
- A. Design Criteria:
 - 1. Refer to Design Criteria on Sheet S-0001 for Load Requirements.
 - 2. All FRP connections shall be 316 Stainless Steel
 - 3. All primary and secondary supports shall be stainless steel, designed and furnished by the FRP manufacturer.
 - 4. All perimeter edge support angles shall be FRP.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings detailing fabrication and erection of each FRP fabrication indicated. Include signed and sealed plans, elevations, sections, and details of FRP fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - 2. Product Data for products used in miscellaneous FRP fabrications including paint products and grout.
 - 3. Where installed FRP fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural

analysis that has been signed and sealed by the qualified Professional Engineer responsible for their preparation.

4. Samples representative of materials and finished products as may be requested by ENGINEER.

B. Quality Control Submittals: Qualification data for firms and persons specified in "Quality Assurance" Paragraph to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Architects, Engineers and Owners, and other information specified.

1.05 QUALITY ASSURANCE:

A. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in Work.

1. Arrange for installation of FRP fabrications specified in this Section by same firm that fabricated them.

B. Engineer Qualifications: Professional Engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project shall sign and seal the shop drawings.

1.06 PROJECT CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which FRP fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. FRP Materials:
 - a. Strongwell Corp:
 - 1) 525 Series, Isophthalic Polyester.
 - 2) 625 Series, Vinylester.
 - b. International Gratings, Inc. (IGI):
 - 1) 2525 Series, Isophthalic Polyester.
 - 2) 2625 Series, Vinylester.
 - c. Resolite:
 - 1) Polyglas M - Polyester.
 - 2) Polyglas C - Vinylester.
2. FRP Stairs, Treads, and Gratings:
 - a. Fibergrate Corp.
 - b. Fowler Fiberglass Grating, Inc.
 - c. IKG Industries.
 - d. IMCO Reinforced Plastics, Inc.

- e. International Grating, Inc.
- f. Strongwell Corp.

2.02 FRP SURFACES

- A. For FRP fabrications exposed to view upon completion of Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for FRP sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- B. FRP resin shall be a corrosion resistant, fire resistant, pultruded-type premium grade isophthalic polyester or vinylester.

2.03 MATERIALS

- A. In exterior applications, all FRP Elements (handrail, guardrail, stringers, and treads) must be of one color, either gray or beige, as selected by ENGINEER.
- B. FRP structural shapes shall be manufactured using a pultruded process utilizing either flame-retardant isophthalic polyester or flame-retardant vinylester resin containing an ultraviolet (UV) inhibitor. A synthetic surface veil shall be the outermost layer of reinforcement covering the entire exterior surface. The FRP shapes shall achieve a flame spread of 25 or less in accordance with ASTM test method E 84. The exterior of the pultruded shapes shall have a 1 mil (0.025 mm) minimum polyurethane protective coating for added UV protection. Dimensional tolerances shall be in accordance with ASTM specification D 3917. FRP shapes shall comply with the following material properties:

Table 1 - Fiberglass Pultruded Material Properties

Material Properties	ASTM Test Method	Psi (MPa)
Pultruded Fiberglass Structural Shapes		
Ultimate tensile strength in longitudinal direction	D 638	30,000 (207), minimum
Ultimate compressive strength in longitudinal direction	D 695	30,000 (207), minimum
Ultimate flexural strength in longitudinal direction	D 790	30,000 (207), minimum
Ultimate shear strength in longitudinal direction	D 3846	5,500 (38), minimum
Ultimate tensile strength in transverse direction	D 638	7,000 (48), minimum
Ultimate compressive strength in transverse direction	D 695	15,000 (103), minimum
Ultimate flexural strength in transverse direction	D 790	10,000 (69), minimum
Ultimate shear strength in transverse direction	D 3846	5,500 (38), minimum
Density (lb/in. ³ (kg/mm ³))	D 792	0.065 (0.00180), minimum
Water absorption (24-h immersion)	D 570	0.60 max, percent by weight
Pultruded Fiberglass Sheet		
Ultimate tensile strength in longitudinal direction	D 638	20,000 (138), minimum
Ultimate compressive strength in longitudinal direction	D 638	20,000 (138), minimum
Ultimate flexural strength in longitudinal direction	D 790	30,000 (207), minimum
Ultimate shear strength in longitudinal direction	D 3846	5,500 (38), minimum
Ultimate tensile strength in transverse direction	D 638	10,000 (69), minimum
Ultimate compressive strength in transverse direction	D 695	15,000 (103), minimum
Ultimate flexural strength in transverse direction	D 790	13,000 (90), minimum
Ultimate shear strength in transverse direction	D 3846	5,500 (38), minimum
Density (lb./in. ³ (kg/mm ³))	D 792	0.064 (0.00177), minimum
Water absorption (24-h immersion)	D 570	0.50 max, percent by weight
Thermal		
Thermal Coefficient of Expansion	D 696	5 x 10 ⁻⁶ (inches with degree F)***
Thermal Conductivity		4 Btu per sq. ft./hour/degree F/in.
Specific Heat		0.028 Btu/lb. degree F
Electrical		
Electric strength, short term in oil, 1/8 inch	D 149	200 vpm*
Electric strength, short term, in oil		35 kV per inch**
Dielectric constant, 60 Hertz	D 150	5.6
Dissipation factor, 60 Hertz	D 150*	0.03
Arc resistance	D 495	120 seconds***
Continued on next page		

Table 1 - Fiberglass Pultruded Material Properties (continued)

Material Properties	ASTM Test Method	Psi (MPa)
Flame Retardant Properties		
Flame resistance	FTMS 402-2023	75/75 Ign. burn seconds
Intermittent flame test	HLT-15	100 rating
Flammability test	D 635	****
Surface burning characteristics	E 84	25 maximum
Flammability class	UL 94	V-0
Temperature index	UL 94	130

Notes to Table 1:

- * Specimen tested perpendicular to laminate face.
 - ** 1-inch long specimen tested parallel to laminate face using 2-inch diameter electrodes.
 - *** Indicates reported value measured in longitudinal direction.
 - **** Average time of burning = 0.5 second, average extent of burning = 15 minutes.
- C. Fiberglass sheet or solid fiberglass bar shall be used to fabricate the internal connectors for the square tube. The internal connectors will be 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm) with length and angularity variable to meet the requirements of each connection. Angular connections shall be fabricated from fiberglass sheet bonded together using a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent to give a minimum thickness of 1-1/2 inches. The angular connections will be fabricated to the proper dimension from the fiberglass sheets that have been bonded together. Fiberglass sheet used for angular connections shall meet the properties specified in Table 1. Fiberglass solid bar, 1-1/2 by 1-1/2-inch, shall be used for the straight connections, and shall meet the properties specified in Table 1.
- D. Rivets shall be nickel copper or nonmetallic.
- E. Bolts shall be 3/8 inch (9.5 mm) diameter, 316 stainless steel.
- F. Adhesive used to bond internal connectors to fiberglass pultruded square tube shall be a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent.

2.04 FABRICATION

- A. FRP Stairs and Treads: All stair components, stringers, frames, supports, and hangers, shall be of standard FRP structural shapes where specified.
1. The treads for the open riser type FRP stairs and landings shall be safety type similar to floor gratings with non-slip nosings.
 2. See Standard Details on Drawings for construction details.

2.05 FRP GRATINGS, DECKING, AND FRAMES

- A. Glass-fiber grating frames shall be fabricated from pultruded structural angles. No metallic fasteners shall be used.

- B. Glass fiber decking shall consist of a solid flat plate bonded to square mesh type or pultruded type grating manufactured of continuous glass fibers completely wetted with polyester resin.
- C. Glass fiber gratings shall be standard square mesh type or pultruded bar type manufactured of continuous glass fibers completely wetted with polyester resin.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate and provide anchorages, setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.
- B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.02 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. All cut edges and holes shall be sealed with a compatible resin system containing an UV inhibitor.
- E. All connections shall be made using a one-piece solid internal connector bonded to the interior of the square tube using an epoxy adhesive and riveted. The following types of connections are defined:
 - 1. All bolted connections shall have a one-piece solid internal connector bonded to the interior of the square tube through which connector holes will be drilled. A minimum 1 inch (26 mm) length of the solid internal connector will be on each side of the drilled hole.
- F. Additional solid internal connector pieces can be bonded with epoxy adhesive to the interior of the square tube as desired.

3.03 INSTALLATION OF FRP BAR GRATINGS AND DECKING

- A. Install gratings and decking to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and/or bar sizes indicated, including installation clearances and standard anchoring details.

- B. Secure removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach toe plates to gratings by bolting, at locations indicated.
- D. Install removable railing sections where indicated in slip-fit sockets secured with expansion anchors into concrete. Accurately locate sockets to match post spacing.
- E. Expansion Joints: Provide expansion joints at locations indicated or, if not indicated, at intervals not to exceed 40 feet. Provide slip joint with internal sleeve extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches of posts.

END OF SECTION

SECTION 07720 – ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Equipment supports.
 - 3. Roof hatches.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
- B. Shop Drawings: For roof accessories.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.064 inch thick.
 - 1. Finish: Two-coat fluoropolymer.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.

2. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange.
4. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
5. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
6. Liner: Same material as curb, of manufacturer's standard thickness and finish.
7. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
8. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
9. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.2 EQUIPMENT SUPPORTS

- A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints, and integrally formed structure-mounting flange at bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.064 inch thick.
 1. Finish: Two-coat fluoropolymer.
 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 2. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 3. Nailer: Factory-installed continuous wood nailers 3-1/2 inches wide on top flange of equipment supports, continuous around support perimeter.
 4. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 5. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 6. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
 7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.3 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
- B. Type and Size: Single-leaf lid, size as indicated on drawings.
- C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.
- D. Hatch Material: Zinc-coated (galvanized) steel sheet.
 - 1. Thickness: Manufacturer's standard thickness for hatch size indicated.
 - 2. Finish: Two-coat fluoropolymer.
 - 3. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
 - 1. Insulation: 2-inch-thick, polyisocyanurate board.
 - a. R-Value: 12.0 according to ASTM C1363.
 - 2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 - 3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 - 4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - 5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 - 6. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
- F. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
- G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
 - 1. Height: 42 inches above finished roof deck.
 - 2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
 - 3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
 - 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
 - 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 - 6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 - 7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 - 8. Fabricate joints exposed to weather to be watertight.

9. Fasteners: Manufacturer's standard, finished to match railing system.
10. Finish: Manufacturer's standard.

- a. Color: As selected by Architect from manufacturer's full range.

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: 42 inches above finished roof deck.
3. Material: Steel tube].
4. Post: 1-5/8-inch- diameter pipe.
5. Finish: Manufacturer's standard baked enamel or powder coat.

- a. Color: As selected by Architect from manufacturer's full range.

2.4 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.

1. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

- a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

B. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

C. Steel Tube: ASTM A500/A500M, round tube.

D. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

E. Steel Pipe: ASTM A53/A53M, galvanized.

2.5 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
- C. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07841 – PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Fire Protection Products.
 - b. A/D Fire Protection Systems Inc.
 - c. Construction Solutions.
 - d. Grabber Construction Products.
 - e. Hilti, Inc.
 - f. HOLDRITE.
 - g. NUCO Inc.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.
 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.3 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION

SECTION 07900 - JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY:

- A. Section Includes: Extent of each form and type of joint sealer as indicated on Drawings and Schedules.
- B. Section includes joint sealers for the following locations:
 - 1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below.
 - a. Control and expansion joints in unit masonry.
 - b. Joints between different materials.
 - c. Perimeter joints between materials and frames of doors and windows.
 - d. Other joints where indicated.
 - 2. Exterior joints in horizontal traffic surfaces as indicated below.
 - a. Control, expansion, and isolation joints in cast-in-place concrete slabs for floors and paving.
 - b. Joints between different materials.
 - c. Other joints as indicated.
 - 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces as indicated below.
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings.
 - c. Perimeter joints of toilet fixtures.
 - d. Other joints as indicated.
 - 4. Interior joints in horizontal traffic surfaces as indicated below.
 - a. Control and expansion joints in cast-in-place concrete slabs.
 - b. Other joints where indicated.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SYSTEM PERFORMANCE:

- A. Provide joints sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data from manufacturer for each joint sealer product required, including instructions for joint preparation and joint sealer application.
 - 2. Samples for Initial Selection Purposes: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available for each product exposed to view.

3. Samples for verification purposes of each type and color of joint sealer required. Install joint sealer samples in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealers.
4. Certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials to Site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.05 PROJECT CONDITIONS:

- A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:
 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 degrees F (4.4 degrees C).
 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by joint sealer manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.06 SEQUENCING AND SCHEDULING:

- A. Sequence installation of joint sealers to occur not less than 21 or more than 30 days after completion of waterproofing, unless otherwise indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Multi-Part Nonsag Urethane Sealant for Use NT:
 - a. "Dymeric 240," Tremco, Inc.
 - b. "Dynatrol II," Pecora Corp.
 - c. "Sikaflex 2c NS", Sika Corp.
 2. One-Part Nonsag Urethane for Use NT:
 - a. "Dymonic," Tremco, Inc.
 - b. "Dynatrol I-XL," Pecora Corp.
 - c. "Sikaflex-15LM," Sika Corp.

3. One-Part Nonsag Urethane Sealant for Use T:
 - a. "Sonolastic NP 1," BASF Building Systems.
 - b. "Sikaflex-1a," Sika Corp.
 - c. "Vulkem 45 SSL," Tremco Sealant/Weatherproofing Division, RPM.
4. One-Part Pourable Urethane Sealant for Use T:
 - a. "Chem-Calk 950," Bostik Construction Products Division.
 - b. "Urexpan NR-201," Pecora Corp.
 - c. "Sikaflex-1CSL," Sika Corp.
 - d. "Vulkem 45," Tremco Sealant/Weatherproofing Division, RPM.
5. Multi-part Nonsag Immersible Polysulfide or Polyurethane Sealant:
 - a. "Synthacalk GC-2+," Pecora Corp.
 - b. "Sonolastic Polysulfide Sealant," Sonneborn, Degussa Building Systems.
 - c. "Vulkem 116," Tremco Sealant/Weatherproofing Division, RPM (non-waste water facilities).
 - d. "Thiokol 2235M," PolySpec Sealant for chemical resistant locations (Water Treatment Concrete Expansion Joints) in conjunction with Thiokol 5050 Epoxy Primer for Polysulfide Sealants.
6. Pre-formed Foam Sealant:
 - a. Horizontal and Traffic Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal EPS," Will-Seal Construction Foams Dw., Illbruck.
 - b. Vertical Applications Above Grade (Control and Expansion Joints):
 - 1) "Emseal Greyflex," Emseal Corp.
 - 2) "Polytite Standard," Sandell Manufacturing Co., Inc.
 - 3) "Will-Seal 150," Will-Seal Construction Foams Dw., Illbruck.
 - c. Below Grade Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal 250," Will-Seal Construction Forms Dw., Illbruck.
 - d. Pre-formed Hollow Neoprene Gasket:
 - 1) The D.S. Brown Co.
 - 2) Watson-Bowman and Acme Corp.
 - 3) Williams Products, Inc.
7. Foamed-In-Place Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Pensil 851," General Electric Co.
8. One-Part Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Fyre Putty," Standard Oil Engineered Materials Co.
 - c. "Metachaulk 1100," The RectorSeal Corporation.
 - d. "RTV 7403," General Electric Co.
 - e. "3M Fire Barrier Caulk CP-25," Electrical Products Division/3M.
9. Joint Sealant Backing:
 - a. Expand-o-Foam, 1380 Series, Williams Products, Inc.
 - b. The D.S. Brown Co.
10. Joint Fillers for Concrete:
 - a. Cementone, W.R. Meadows.
 - b. Concrete Grey Sponge Rubber, 1300 Series, Williams Products, Inc.

2.02 MATERIALS, GENERAL:

- A. Compatibility: Provide joint sealers, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application as demonstrated by sealant manufacturer based on testing and field experience.

2.03 ELASTOMERIC JOINT SEALANTS:

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those referenced for type, grade, class, and uses.

Abbreviations

Types, Grade, Uses (Exposure)

S	Single component	Type
M	Multi-component	Type
P	Pourable	Grade
NS	Nonsag	Grade
NT	Nontraffic	Use
T	Traffic	Use
I	Immersion	Use

Uses (Joint Substrates)

A	Aluminum
O	Other
G	Glass
M	Mortar

Class 25 Sealants 25 Percent movement capability

- B. Multi-Part Nonsag Urethane Sealant for Use NT: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
 - 1. Uses NT, M, A, and, as applicable to joint substrates indicated, O.
 - 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER from manufacturer's standard colors.
- C. One-Part Nonsag Urethane Sealant for Use NT: Type S, Grade NS, Class 25, and Uses NT, M, A, and, as applicable to joint substrates indicated, O.
 - 1. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by OWNER from manufacturer's standard colors.

- D. One-Part Nonsag Urethane Sealant for Use T: Type S, Grade NS, Class 25, and complying with the following requirements for Uses:
 - 1. Uses T, NT, M, G, A, and, as applicable to joint substrates indicated, O.
 - 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER from manufacturer's standard colors.
- E. One-Part Pourable Urethane Sealant for Use T: Type S, Grade P, Class 25, and complying with the following requirements for Uses:
 - 1. Uses T, M, A, and, as applicable to joint substrates indicated, O.
 - 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER from manufacturer's standard colors.
- F. Multi-Part Nonsag Polysulfide or Polyurethane Sealant for Uses T, NT, I: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
 - 1. Uses T, NT, I, M, G, A, and, as applicable to joint substrates indicated, O.
 - 2. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by OWNER from manufacturer's standard colors.

2.04 COMPRESSION SEALS:

- A. Pre-formed Foam Sealant: Manufacturer's standard pre-formed, pre-compressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellent agent; factory-produced in pre-compressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer; and complying with the following requirements:
 - 1. Properties: Permanently elastic, mildew-resistant, nonmigratory, nonstaining, compatible with joint substrates and other joint sealers.
 - 2. Impregnating Agent:
 - a. Chemically stabilized acrylic (EMSEAL).
 - b. Neoprene rubber suspended in chlorinated hydrocarbons (WILL-SEAL).
 - c. Polymerized polybutylene (POLYTITE).
 - 3. Density: 8 - 10 pounds per cubic foot.
 - 4. Backing: None.
- B. Pre-formed Hollow Neoprene Gasket: Manufacturer's standard pre-formed polychloroprene elastomeric joint seal of the open-cell compression type complying with ASTM D 2628 and with requirements indicated for size, profile, and cross-sectional design.

2.05 JOINT SEALANT BACKING:

- A. Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers: Pre-formed, compressible, resilient, nonwaxing, nonextruding strips of flexible, nongassing plastic foam of material indicated below; nonabsorbent to water and gas; and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance
- C. Either open-cell polyurethane foam or closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer, for cold-applied sealants only.

- D. Elastomeric Tubing Joint Fillers: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -26 degrees F (-15 degrees C). Provide products with low compression set and of size and shape to provide a secondary seal, control sealant depth, and otherwise contribute to optimum sealant performance.
- E. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS:

- A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealer substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Provide nonstaining, chemical cleaners of type which are acceptable to manufacturer of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, do not leave oily residues, or otherwise have a detrimental effect on sealant adhesion or in-service performance.
- C. Masking Tape: Provide nonstaining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

2.07 JOINT FILLERS FOR CONCRETE:

- A. Provide joint fillers of thickness and widths indicated.

Sponge Rubber Joint Filler: Pre-formed strips complying with ASTM D 1752 for Type I.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS:

- A. Installer Qualifications: Engage an installer who has successfully completed, within the last 3 years, at least 3 joint sealer applications similar in type and size to that of this Project.

3.02 EXAMINATION:

- A. Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

3.03 PREPARATION:

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

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1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealers, oil, grease, waterproofing, water repellants, water, surface dirt, and frost.
 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form release agents from concrete.
 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on pre-construction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.04 INSTALLATION OF JOINT SEALERS:

- A. Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.
 - d. See Standard Detail on Drawings for face brick control joint application.
 2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.
 3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.
 4. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

- a. Note: Install all sealant in interior joints after painting of adjoining surfaces have been performed. Do not paint over sealant joints.
- D. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
 - 1. Provide concave joint configuration per Figure 6A in ASTM C 962 unless otherwise indicated.
 - 2. Provide flush joint configuration per Figure 6B in ASTM C 962 where indicated.
 - 3. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 - 4. Provide recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated.
- E. Installation of Pre-formed Foam Sealants: Install each length of sealant immediately after removing protective wrappings, taking care not to pull or stretch material, and complying with sealant manufacturer's directions for installation methods, materials, and tools which produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.
- F. Installation of Pre-formed Hollow Neoprene Gaskets: Install gaskets, with minimum number of end joints, in joint recesses with edges free of spalls and sides straight and parallel, both within tolerances specified by gasket manufacturer. Apply manufacturer's recommended adhesive to joint substrates immediately prior to installing gaskets. For straight sections, provide gaskets in continuous lengths; where changes in direction occur, adhesively splice gaskets together to provide watertight joint. Recess gasket below adjoining joint surfaces by 1/8 to 1/4 inch.

3.05 CLEANING:

- A. Clean off excess sealants or sealant smears adjacent to joints as Work progresses, by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.06 PROTECTION:

- A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original Work.

END OF SECTION

SECTION 08220 - FIBERGLASS REINFORCED PLASTIC DOORS AND ALUMINUM FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Section includes fiberglass reinforced plastic (FRP) doors and aluminum frames.

1.02 REFERENCES

- A. Michigan Building Code (MBC)
- B. American Society for Testing and Materials (ASTM) Specifications
 1. A 123 Zinc Coatings
 2. C 591-01 Unfaced Preformed Rigid Cellular Polyisocyanurate.
 3. C 728-97 Insulation Board, Mineral Aggregate
 4. E 330-97 Structural Load Test
 5. E 1996 Wind Load Test
 6. E 1886 Impact Test Procedures (inclusive of Large Missile Impact)
- C. Door and Frame Preparation for Hardware, American National Standard Institute Specifications (ANSI)
- D. Recommended Locations for Builder's Hardware, Door and Hardware Institute (DHI)
- E. Aluminum Association, Inc. (AA).
 1. AA5005-H14 – Sheet Architectural.
 2. AA6061-T6 Heavy Duty Structures.
 3. AA6063-T5 Extrusions, Pipe, Architectural.
 4. AA DAF-45 Designation System for Aluminum Finishes.
- F. American Architectural Manufacturers Association (AAMA)
 1. AAMA 2603-98 Pigmented Organic Coatings
 2. AAMA 609 Anodized Architectural Finishes Cleaning and Maintenance.
 3. AAMA 611-98 Anodized Architectural Standards.

1.03 PERFORMANCE REQUIREMENTS

- A. Exterior FRP doors shall be designed to meet wind-loading requirements for the MBC. Refer to Structural Drawings for wind and design pressures.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01300. Include copies of manufacturer's specifications for fabrication and installation including certifications, data and test reports substantiating that products comply with requirements.
- B. Submit shop drawings showing sizes and complete details of doors. Include details of core and edge construction, trim for openings and similar components. Include finishing specifications for doors to receive factory-applied shop finish.

- C. Provide a schedule of doors and frames using same reference designations for details and openings as indicated on the Contract Drawings.
- D. Furnish to the Owner six (6) copies of an Operating and Maintenance Data in accordance with Division 1. The manual shall consist of maintenance instructions for doors and frames; catalog pages for each product; name, address and phone number of the local representative of each manufacturer; and copy of the approved shop drawings.

1.05 PRODUCT HANDLING

- A. Doors are to be stacked flat in a dry and protected area in original cartons prior to installation. Provide blocking or staging to protect door surfaces. Do not drag doors across one another. Lift doors and carry them into position. Identify each door with individual opening designations, as indicated on the approved shop drawings, using concealed markings.

1.06 WARRANTY

- A. Submit written agreement in door manufacturer's standard form signed by manufacturer, Installer and Contractor, agreeing to repair or replace defective doors which have separated, delaminated from the core, expansion of the core, or otherwise failed due to defects in material and workmanship, improper installation, or corrosion from a specified environment, for a period of not less than five (5) years.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Marshall/Vega Corporation, Marshall, Arkansas.
- B. Cline Aluminum Doors, Inc., Bradenton Florida.
- C. Tiger Door, LLC
- D. Substitutions: Manufacturers and model numbers listed are to establish a standard of quality. Similar items by other manufacturers that are equal in design, function and quality will be considered for prior approval provided required data and physical samples are submitted under provisions of Section 01300.

2.02 FIBERGLASS REINFORCED PLASTIC (FRP) DOORS

- A. Aluminum Members: Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish.
- B. FRP Door Composite Components: Minimum 3-ply composite laminated construction to include:
 - 1. Facing: 0.120-inch (3.05 mm) composite FRP panel exterior grade, UV-protected fiber reinforced polyester panel on interior and exterior faces. Ultraviolet inhibitors shall be maximum amount formulated within the resin. Exterior and interior FRP panels shall be a Class C Flame Spread: Maximum of 75, and Smoke Developed Rating of 450 or less (ASTM E 84)

2. Surface texture will be pebble embossed with a non-directional pattern.
3. All mylar transporter fabrication film must be removed from FRP face sheets prior to door fabrication.
4. Face sheet shall be bonded to core and backup tube from edge to edge of door.
5. FRP face sheets shall be a Class C Flame Spread: Maximum of 75 and Smoke Developed rating of 450 or less (ASTM E 84), for both interior and exterior faces of interior and exterior doors.
6. Core: Organic materials shall be used to form a marine grade honeycomb core with high compression strength of 94.8 psi (ASTM C365), and internal aluminum hardware backup tube.
7. Hardware Backup: The hardware backup tube shall be a minimum 4.25-inches (107.95 mm) in width, 1.375-inches (34.93 mm) in depth with a wall thickness of 0.125-inches (3.18 mm). Contiguous for the full perimeter of the door to allow for all specified and non-specified hardware reinforcement.
8. Hardware Prep: Basic to include mortise lock edge prep or cylindrical lock prep; and pairs prepped for flush bolts, if required.
9. Bonding Agent: Environmentally friendly adhesive with strength buildup of 350 pounds per square inch (24.6 kg/cm²).
10. Perimeter Door Trim: Wall thickness of 0.050-inch (1.25 mm) minimum in 6063-T5 extruded aluminum alloy with special beveled edge cap design and integral weather stripping on lock stile.
11. Replaceable Door Trim: Mechanically fastened to the hardware backup tube, allowing for replacement in the field, if damaged.
12. Trim Finish: To have minimum of a Class I anodized finish.
13. Weather stripping: Replaceable wool pile with nylon fabric, polypropylene backing meeting AAMA 701 standards. Applied weather stripping not acceptable.
14. Materials: Only nonferrous, non-rusting members shall be acceptable, including tie rods, screws and reinforcement plates.
15. Regulations: All components and agents to meet EPA standards.
16. Color: As indicated on plans or, if not otherwise indicated, as selected by Owner from manufacturers' full range of standard colors.

C. Door Louvers:

1. Blades and Frames: 6063 –T5 extruded aluminum alloy, 0.062 inch minimum thickness. Louver blades shall be inverted “Y” type.
2. Insect Screens: 18-16 mesh, 0.111 inch diameter aluminum set in 6063 –T5 extruded aluminum alloy frame, 0.050 in minimum thickness.
3. Louver shall have minimum of 50% free air flow.

2.03 ALUMINUM FRAMES

- A. Frame Components: Extruded channel (tubular) 6063-T5 aluminum alloy, minimum wall thickness 0.125 inches; cut corners square and joinery shall be mechanical with no exposed fasteners
- B. Profile: Open back with applied stop (OBS), 1.75 inches x 6”.
- C. Hinge and Strike Mounting Plates: Extruded aluminum alloy bar stock, 0.187r thick mounted in concealed integral channel with no exposed fasteners.
- D. Door Stop: No screw on stops acceptable.

- E. Frame Finish: Shall be Clear anodic coating; AA-M12C22A31 Class II mechanical finish, non-specular, with chemical medium matte etch, minimum thickness 0.4 mil.
- F. Color: As indicated on plans or, if not otherwise indicated, as selected by Owner from manufacturers' full range of standard colors.

2.04 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
 - 1. Do not use exposed fasteners.
- B. Brackets and Reinforcements: Manufacturer's high strength aluminum units where feasible, otherwise nonferrous stainless steel.
- C. Bituminous Coating: Cold applied asphaltic mastic, compounded for 30 mil thickness per coat.

2.05 OBSERVATION WINDOW FRP FRAME

- A. Provide observation window FRP frames as shown on Drawings and Schedules. Frames shall be double rabbeted, 1/8-inch minimum thickness FRP, depth as shown or scheduled, with 2-inch jamb and sill widths. Head section shall be heights as shown or required. Frames shall be fabricated with mitered and bonded corners with concealed fasteners. Provide glass stops and appropriate anchors for securely holding frames in walls.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify upon delivery that all doors and frames comply with the approved shop drawings and meet the indicated requirements for type, size, location and swing. Examine each opening for conditions that would prevent the proper application of doors, frames and related items. Do not proceed until defects are corrected.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings; set frames plumb, square, level, and aligned to receive doors.
- B. Anchor frames to adjacent construction in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
 - 1. Seal metal-to-metal joints between framing members using good quality elastomeric sealant.
- C. Where aluminum surfaces contact with metals other than stainless steel, zinc or small areas of white bronze, protect from direct contact by one or more of the following methods.
 - 1. Paint dissimilar metal with one coat of heavy-bodied bituminous paint.
 - 2. Apply good quality elastomeric sealant between aluminum and dissimilar metal.
 - 3. Paint dissimilar metal with one coat of primer and one coat of paint recommended for aluminum surface applications.

4. Use non-absorptive tape or gasket in permanently dry locations.
- D. Hang doors with required clearances as follows:
 1. Hinge and Lock Stiles: 0.125 inch (3.18 mm).
 2. Between Meeting Stiles: 0.250 inch (6.35 mm).
 3. At Top Rails: 0.125 inch (3.18 mm).
 4. Between Door Bottom and Threshold: 0.125 inch (3.18 mm).
 - E. Adjust doors and hardware to operate properly.
 - F. Install hardware for doors of this section.
 - G. Installation of door hardware is specified in Section 08710.

3.03 CLEANING

- A. Upon completion of installation thoroughly clean door and frame surface in accordance with AAMA 609.
- B. Do not use abrasive, caustic or acid cleaning agents.

3.04 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until substantial completion.
- B. Repair damage or defect products to original specified condition in accordance with manufacturer's recommendations.
- C. Replace damaged or defective products that cannot be repaired to the Architect's acceptance.

END OF SECTION

SECTION 08911 – FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fixed extruded-aluminum louvers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
- C. Samples: For each type of metal finish required.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on tests performed according to AMCA 500-L.
- B. Sample warranties.

1.4 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver

components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.

1. Wind Loads:

a. Determine loads based on pressures as indicated on Drawings.

B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

2.2 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Drainable-Blade Louver, Extruded Aluminum:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Airolite Company, LLC (The).
- b. Greenheck Fan Corporation.
- c. Industrial Louvers Inc.
- d. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

2. Louver Depth: 4 inches.

3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.

4. Mullion Type: Exposed.

5. Louver Performance Ratings:

- a. Free Area: Not less than 7.0 sq. ft. for 48-inch-wide by 48-inch-high louver.
- b. Point of Beginning Water Penetration: Not less than 900 fpm..
- c. Air Performance:

1) Not more than 0.10-inch wg static pressure drop at 700-fpm free-area exhaust velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.3 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

- 1. Screen Location for Fixed Louvers: Interior face.
- 2. Screening Type: Bird screening.

B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.

C. Louver Screening for Aluminum Louvers:

1. Bird Screening, Aluminum: 1/2-inch-square mesh, 0.063-inch wire.

2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
 - 3. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

- A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

3.2 ADJUSTING

- A. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION

SECTION 09672 – RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes resinous flooring systems.

1.2 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing according to ASTM D 635.

2.2 RESINOUS FLOORING RF

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with Section 10 73 00 Execution 2.1.C Table of DTE Energy Standard Finishes and Materials.
- C. System Characteristics:
 - 1.
 - 2. Wearing Surface: Textured for slip resistance.
 - 3. Overall System Thickness: 1/4 inch (6.4 mm).
- D. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- E. Reinforcing Membrane: Flexible resin formulation that is recommended by resinous flooring manufacturer.
- F. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
 - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
 - 3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - a. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 1. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.
- D. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness indicated for flooring system.
- E. Grout Coat: Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.
- F. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.
- G. Protect resinous flooring from damage and wear during the remainder of construction period.

END OF SECTION

SECTION 09960 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Interior Substrates:
 - a. Concrete, horizontal surfaces.

1.2 DEFINITIONS

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, products listed in the Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Concrete Substrates, Vertical Surfaces:
- B. Concrete Substrates, Horizontal Surfaces.

1. Epoxy, High-Build System MPI INT 3.2L:

- a. Prime Coat: High-build epoxy, matching topcoat (reduced).
- b. Intermediate Coat: High-build epoxy, matching topcoat.
- c. Topcoat: High-build epoxy, low gloss, MPI #108.

- 1) Benjamin Moore (Carboline) Polyamide Epoxy Semi-Gloss.
- 2) PPG Architectural)Protective and Marine Coatings) Aquapon High Build Epoxy.
- 3) Sherwin-Williams (protective & Marine) Macropoxy 646 Fast Cure Epoxy.

END OF SECTION

SECTION 09961 - HIGH PERFORMANCE PAINTS AND COATINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied.
 - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
 2. Environmental Protection Agency (EPA).
 3. International Concrete Repair Institute (ICRI) Guideline No. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 4. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 5. ANSI / NSF International (NSF): 61, Drinking Water System Components- Health Effects.
 6. National Association of Pipe Fabricators (NAPF)
 - a. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
 7. Occupational Safety and Health Act (OSHA).
 8. The Society for Protective Coatings (SSPC):
 - a. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - b. SSPC-PA 3, Guide to Safety in Paint Applications.
 - c. SSPC-SP 1, Solvent Cleaning.
 - d. SSPC-SP 2, Hand Tool Cleaning.
 - e. SSPC-SP 3, Power Tool Cleaning.
 - f. SSPC-SP 5/NACE 1, White Metal Blast Cleaning.
 - g. SSPC-SP 6/NACE 3, Commercial Blast Cleaning.
 - h. SSPC-SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SSPC-SP 10/NACE 2, Near-White Blast Cleaning.

- j. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
 - k. SSPC-SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
 - l. SSPC-SP 13/NACE 6, Surface Preparation of Concrete.
 - m. SSPC-SP 16, Brush-off Blast cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
 - n. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
 - o. SSPC-TU 11, Inspection of Fluorescent Coating Systems.
- 9. National Fire Protection Association (NFPA).
 - 10. American Society for Testing and Materials (ASTM International).

1.02 SUMMARY

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.
- C. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- D. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- E. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- F. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.
- G. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by Contractor prior to any storage or installation.
- H. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated.
- I. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

- J. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.
- K. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.
- L. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.
- M. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- N. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
1. No Factory Finish: Surface preparation, priming, and finish painting.
 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
 5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
- O. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- P. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
1. Exterior exposed concrete surfaces and exterior exposed concrete surfaces below the ground floor plan.
 2. Nonferrous metals and stainless steel, except copper and brass.
 3. Exterior aluminum siding.
 4. Nonexposed surfaces of treated lumber.
 5. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.

6. Conduits below the main floor, except in rooms that are painted.
7. Exterior gratings with a hot-dipped galvanized finish.
8. Manufacturer's name and identification plates, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
9. Overhead sectional doors - shall have a factory finish on both interior and exterior exposed surfaces.
10. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by Engineer.
11. Interior concrete surfaces of tanks and basins, immersed and exposed not to be painted.
12. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motors, and fan shafts will not require finish painting.

1.03 DEFINITIONS

A. Terms used in this section:

1. ASTM D 16, unless otherwise specified.
2. Coverage: total-minimum dry film thickness in mils or square feet per gallon.
3. DFT: Dry Film Thickness – Thickness of a coat of cured paint measured in mils (1/1000 inch).
4. FRP: Fiberglass Reinforced Plastic.
5. HCl: Hydrochloric Acid.
6. MDFT: Minimum Dry Film Thickness, mils.
7. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
8. Mil: Thousandth of an inch.
9. PDS: Product Data Sheet.
10. PSDS: Paint System Data Sheet.
11. PVC: Polyvinyl Chloride.
12. SFPG: Square Feet per Gallon.
13. SFPGPC: Square Feet per Gallon per Coat.

14. SP: Surface Preparation.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit in accordance with Division 1 Submittal Procedures.

a. Data Sheets:

- 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
- 2) For each paint system, furnish a Paint System Data Sheet (PSDS).
- 3) Technical and performance information that demonstrates compliance with Specification.
- 4) Furnish copies of paint system submittals to the coating applicator.
- 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.

b. Detailed chemical and gradation analysis for each proposed abrasive material.

2. Samples:

a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

b. Reference Panel:

1) Surface Preparation:

- a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
- b) Provide panel representative of the steel used; prevent deterioration of surface quality.
- c) Panel to be reference source for inspection upon approval by Engineer.

2) Paint:

- a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
- b) Furnish additional samples as required until colors, finishes, and textures are approved.
- c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Typewritten schedule of Painting Operations. This schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and number of coats in order to achieve the specified dry film thickness, and color charts.
2. Coating manufacturer's Certificate of Compliance, in accordance with Division 1, Manufacturers' Field Services.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

C. Warranty:

1. Submit manufacturer's standard warranty in accordance with requirements of Division 1, warranties covering the items included under this Section.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. SSPC PA 3, Guide to Safety in Paint Applications.
 - c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.

2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

D. Pre-application Meeting:

1. Convene a pre-application meeting two [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer's representative. Review the following:
 - a. Environmental requirements.
 - b. Protection of surfaces not scheduled to be coated.
 - c. Surface preparation.
 - d. Application.
 - e. Repair.
 - f. Field quality control.
 - g. Cleaning.
 - h. Protection of coating systems.
 - i. One-year inspection.
 - j. Coordination with other work.

- E. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

- F. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

- B. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:

1. Name or title of material.
2. Fed. Spec. number, if applicable.
3. Manufacturer's stock number, batch number, and date of manufacturer.
4. Manufacturer's name.

5. Contents by volume, for major pigment and vehicle constituents.
6. Thinning instructions.
7. Application instructions.
8. Color name and number.

C. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.
3. Handling: Protect materials during handling and application to prevent damage or contamination.
4. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than

5 degrees F above dew point of ambient air.
3. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
4. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
5. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within

temperature limits specified by paint manufacturer during application and drying periods.

6. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer's printed instructions.

B. Status of Existing Coatings:

1. Perform tests as required to verify condition of existing coatings and substrate conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
 1. TNEMEC Company, Inc.
 2. The Sherwin-Williams Company.
 3. PPG Industries.
 4. Carboline.

2.02 ABRASIVE MATERIALS

- A. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
- B. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
 1. Manufacturer's highest quality products suitable for intended service. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
4. Color Pigments: Pure, non fading, applicable types to suit substrates and service indicated.
 - a. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non volatile (dry film) of paint by weight.

B. Products:

Product	Definition
Acrylic Latex	Single-component, 100% acrylic finish as required
Block Filler	Primer-sealer designed for rough masonry surfaces, acrylic emulsion, cementitious acrylic, or epoxy
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type, suitable for immersion service
Epoxy Filler/Surfacers	100% solids epoxy trowel grade filler and surface, nonshrinking, suitable for application to concrete and masonry
Epoxy Nonskid (Aggregated)	100% solids two-component catalyzed epoxy aggregated; aggregate may be packaged separately
Epoxy Primer-Ferrous Metal	High-build, two-component catalyzed epoxy primer.
Epoxy Primer- Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	High-build, two-component catalyzed epoxy, capability of 3 to 5 MDFT per coat
Epoxy Novolac	100% solids two-component, highly chemical resistant epoxy
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.
Gloss Polyurethane -	Two-component, aliphatic acrylic based polyurethane; high gloss finish
Reinforced High Build Epoxy	100% solids high build, high strength, single leg or plural component application, highly chemical resistant, glass flake reinforced epoxy.
Multipolymeric Matrix Coating	Heat resistant single component inert multipolymeric matrix coating for high heat applications under insulation.
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.

5. Mix only components specified and furnished by paint manufacturer.
 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
- B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
1. Colors: Formulate paints with colorants for reasons of color or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.
- B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.
- C. Shop Coating Requirements:
1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
 2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.
- D. Pipe:
1. Steel and Ductile Iron Pipe:
 - a. Prepare steel surfaces in accordance with SSPC SP-6, Commercial Blast Cleaning with a surface profile of 2 to 3 MILS.
 - 1). Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain. Bituminous coated pipe shall NOT be allow if field painting is required.
 - 2). Bituminous coated pipe shall NOT be allow if field painting is required.

- 3). Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
- b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
- c. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer or their representative, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.
- D. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations. At completion of work of other trades, touch up and restore all damaged or defaced painted surfaces.

3.02 EXAMINATION

- A. Factory Finished Items:
 1. Scheduling Inspection with Engineer before repairing damaged factory finished items delivered to Site.
 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.
- C. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.
- D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions

otherwise detrimental to formation of a durable paint film.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition, or as required by this specification, the more stringent requirements shall apply.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
 - 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
 - 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
 - 4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
 - 5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
- B. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.

2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
 - a. SSPC-SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
 - b. SSPC-SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
 - c. SSPC-SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
 - d. SSPC-SP 5/NACE 1, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
 - e. SSPC-SP 6/NACE 3, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - f. SSPC-SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
 - g. SSPC-SP 10/NACE 2, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides: corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - h. SSPC-SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
 - i. SSPC-SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high- pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.

2. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Welds and Adjacent Areas:
 - a. Prepare such that there is:
 - 1) No undercutting or reverse ridges on weld bead.
 - 2) No weld spatter on or adjacent to weld or any area to be painted.
 - 3) No sharp peaks or ridges along weld bead.
 - b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
7. Pre-blast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
8. Blast Cleaning Requirements:
 - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
9. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

- b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Prepare galvanized steel and nonferrous metal surfaces in accordance with SSPC-SP16 and the coating manufacturer's instructions.
2. Test galvanized surfaces for chromate treatments and remove as required by SSPC-SP 16, or other Engineer approved method.
3. Ensure surfaces are dry.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13/NACE 6 and ICRI 310.2.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.
4. Abrasive blast clean to remove loose concrete and laitance, and provide an ICRI CSP profile as required by paint manufacturer.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry

Prior to painting. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method, and, if necessary, ASTM F1869, Measuring Moisture Vapor Emission Rate of Concrete. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
7. If surfaces are found to be sufficiently alkaline to cause blistering and burning off of finish paint, correct this condition before application of paint.

F. Plastic and FRP Surface Preparation:

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

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
 - a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
 - b. Brush-off blasting.
 - c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
 - a. Synthetic-based wood putty approved by paint manufacturer for paint system.
 - b. For natural finishes, color of wood putty shall match color of finished wood.
 - c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
 - d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
 - e. Use cellulose type putty for stained wood surfaces.

5. Ensure surfaces are clean and dry prior to painting.
 6. Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling.
- I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.
1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.
- J. Galvanized Surfaces: SSPC SP 16.
- K. Existing Painted Surfaces to be Repainted Surface Preparation:
1. Detergent wash and freshwater rinse.
 2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
 3. Feather surrounding intact coating.
 4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
 5. Apply one full finish coat of specified primer to entire surface.
 6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
 7. For ductile iron pipe with asphaltic varnish finish not specified to be abrasive blasted, apply coat of tar stop prior to application of cosmetic finish coat.
 8. Application of Cosmetic Coat:
 - a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
 - b. Check compatibility by application to a small area prior to starting painting.
 9. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.
- L. Shop Primed Surfaces: Prepare shop-applied prime coats wherever damaged or bare as required by other sections of these Specifications. Clean and touch-up with same type shop primer.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new interior masonry, interior and exterior wood, and metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements

shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.

5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
13. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
14. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
15. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.
16. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.
 - a. Piping, pipe hangers, supplementary steel and supports (except galvanized surfaces).
 - b. Heat exchangers.
 - c. Tanks.
 - d. Ductwork, insulation.
 - e. Motor, mechanical equipment, and supports.
 - f. Accessory items.
 - g. Conduits and fittings (except galvanized surfaces).
 - h. Switchgear.
 - i. Hanger and support (except galvanized surfaces).
17. Provide finish coats which are compatible with prime paints used.

18. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 19. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.
 20. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
 21. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.
- B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:
1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
 2. Prepare surface and apply primer in accordance with System No. 5 specification.
 3. Apply intermediate and finish coats of the coating system appropriate for the exposure.
- C. Porous Surfaces, Such As Concrete and Masonry:
1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
 2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
 3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.
- D. Film Thickness and Coverage:
1. Number of Coats:
 - a. Minimum required without regard to coating thickness.

- b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
 - a. Do not exceed coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
 3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
 4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
 5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
 6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. The Finish Schedule on Architectural Drawings addresses walls, floors and ceilings for various buildings. Additional requirements are included in the following schedule which addresses structural steel, prefabricated steel trusses, process equipment, pumps, piping and other items.
- C. NSF International approval required for coatings used in contact with the water treatment plant process water.
- D. System No. 1 Steel Submerged in Process or Wastewater:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 10/NACE 2, Near White Blast Cleaning	High Build Chemical Resistant Epoxy (Flake-Filled preferred). Coal Tar Epoxy is NOT acceptable.	OPTIONAL Shop Primer 2 coats, 8.0 – 12.0 MDFTPC

1. Use on the following items or areas:

Metal surfaces new and existing below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete.

E. System No. 2 Exposed Metal-: Exterior

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 6/NACE 3, Commercial Blast Cleaning with a surface profile of 2 to 3 MILS.	Epoxy Primer- Ferrous Metal	1 coat, 3 to 5 MDFT
	High Build Epoxy	1 coat, 3 to 5 MDFT
	Gloss Polyurethane	1 coat, 2 to 4 MDFT

1. Use on the following items or areas:

Exposed metal surfaces, new and existing located outside of structures and exposed to weather, and the following specific surfaces:

- 1) Exposed metal surfaces, piping and equipment in the headworks.
- 2) Exposed process piping above grade and within structures or vaults.

F. System No. 3 Exposed Metal-: Interior

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 6/NACE 3, Commercial Blast Cleaning with a surface profile of 2 to 3 MILS	Epoxy Primer- Ferrous Metal	1 coat, 3 to 5 MDFT
	High Build Epoxy	1 coat, 3 to 5 MDFT
	High Build Epoxy	1 coat, 3 to 5 MDFT

2. Use on the following items or areas:

Exposed metal surfaces, new and existing located inside of structures and the following specific surfaces:

- 3) Exposed metal surfaces, piping and equipment in the headworks.
- 4) Exposed process piping above grade and within structures or vaults.

G. System No. 4 Skid-Resistant- Concrete:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG 10 MDFT plus aggregate

1. Use on the following items or areas:
 - a. Use on floors per finish schedule except floors within chemical storage and feed areas.

H. System No. 5 Interior Concrete and Masonry Walls, Non-immersion, vertical and horizontal surfaces:

1. Epoxy, High-Build System MPI INT 3.2L:
 - a. Prime Coat: High-build epoxy, matching topcoat (reduced).
 - b. Intermediate Coat: High-build epoxy, matching topcoat.
 - c. Topcoat: High-build epoxy, low gloss, MPI #108.
 - i. Benjamin Moore (Carboline) Polyamide Epoxy Semi-Gloss.
 - ii. PPG Architectural)Protective and Marine Coatings) Aquapon High Build Epoxy.
 - iii. Sherwin-Williams (protective & Marine) Macropoxy 646 Fast Cure Epoxy.

I. System No. 6 Exposed FRP, PVC Plastic Piping, Valves, Fittings, and Conduit, Interior and Exterior

Surface Prep	Paint Material	Min. Coats, Cover
In accordance with Paragraph 3.02 Surface Preparation, including cleaning and washing with detergent to remove all dirt and foreign material, and light surface abrasion using medium grade sandpaper. Remove dust, dirt and debris with clean rags prior to coating.	Two component epoxy.	1 coat, 3.0 MDFT
	Hi-Build Epoxy	1 coat, 3.0 MDFT
		Total min. system coating thickness: 6.0 MDFT

1. For PVC or fiberglass piping or electrical systems requiring color coding, and for protection of exposed, exterior plastic components from the elements, and shall include the following:
 - a. PVC and fiberglass piping, fittings, valves, and electrical conduits requiring color coding in accordance with Section 15050: Process and Utility Piping, Fittings, Valves, and Accessories.
 - b. Exposed exterior plastic piping, valve, and fitting components subject to UV degradation and weathering by the elements.

J. System No. 7 Exposed Exterior Concrete and Masonry, Non-immersion.

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 2 or 3. Clean and dry.	Filler/Surfacer: Fill bug holes, air pockets and other voids to provide a continuous substrate. Prime in accordance with manufacturer's recommendations. Primer: As required by manufacturer. Elastomeric Acrylic Hi-Build Waterproofing Coating	1 coat as required to fill voids. 1 coat, 6.0 – 9.0 MDFT Finish Coat: 2 coats, 6.0 – 9.0 MDFT per coat Total min. system coating thickness over surfacer and primer: 12.0 MDFT

1. For exposed exterior concrete (non-immersion) at above grade Ground Storage Tank and Blending Basin locations.
2. Finish Color: As selected by Owner from manufacturer's full range of standard colors.

3.08 COLORS

- A. Provide as shown for equipment and appurtenances and designated herein and shown in Piping Schedule.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
 1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint equipment and piping one color as selected.

3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
 - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
 - b. Fire Protection Equipment and Apparatus: OSHA Red.
 - c. Radiation Hazards: OSHA Purple.
 - d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code non-submerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Piping Color Schedule: In accordance with Piping Schedule.
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Owner.
5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

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

B. Testing:

1. Thickness and Continuity Testing by Contractor:
 - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for

- correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
- b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
 - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
 - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- D. Unsatisfactory Application:
1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 3. Repair defects in accordance with written recommendations of coating manufacturer.
- E. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.
- F. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:
1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.
 2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness,

recoating, skinning, color retention, alkali resistance and quantitative materials analysis.

- G. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.10 MANUFACTURER'S SERVICES

- A. In accordance with Division 1, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
 - 1. On first day of application of any coating system.
 - 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
 - 3. As required to resolve field problems attributable to or associated with manufacturer's product.
 - 4. To verify full cure of coating prior to coated surfaces being places into immersion service.
 - a. Inspection Reports: Submit written reports to Engineer and Contractor describing inspections made and actions taken to correct nonconforming work. Report nonconforming work not corrected.
 - b. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.11 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. As soon as painting Work is accepted by Contactor, it shall become its responsibility for protection, final cleaning, and tough-up. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color. Repair coating defects in accordance with manufacturer's written instructions.

- E. Upon completion of painting work, clean window glass and other paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.12 ONE-YEAR INSPECTION

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.
- C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

3.13 SUPPLEMENTS

- A. The supplements listed below, and following "End of Section," are a part of this Specification:
 1. Piping Color Schedule – To facilitate identification of piping in Water Treatment Plants and Pumping Stations follow the Ten states Identification System unless otherwise noted.
 2. Paint System Data Sheet (PSDS)
 3. Product Data Sheet (PDS)

3.14 STENCILING

- A. The Contractor shall supply all materials and labor necessary for stenciling of legends on pipes. The legend shall show the name of the contents. Review by the Architect-Engineer of legends will be required. Names shall be "plainly visible". Arrows showing direction of flow shall also be stenciled on pipes. The legends shall be located not more than 10 feet apart and, in general, at each valve and piece of equipment. The size and location of the legend shall be in general accordance with ANSI A13.1-1981 "Scheme for the Identification of Piping Systems". All visible piping 6" in diameter and larger shall be color-coded and stenciled. "Stick-on" labels are not acceptable.

Size of Identification Letters	
Outside Diameter of Pipe or Covering (inches)	Size of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
over 10	3-1/2

3.15 PLASTIC IDENTIFICATION MARKERS

- A. All visible piping 3/4" and greater and less than 6" which is accessible for maintenance operations shall be color-coded and identified with semi-rigid plastic identification markers equal to SETMARK Pipe Markers as manufactured by Seton Name Plate Corporation, New Haven, Conn.; T & B/Westline, Los Angeles, California; or equal. Direction of flow arrows are to be included on each marker, unless otherwise specified.
- B. Each marker background is to be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ANSI A 13.1 - 1981).
- C. For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1-1/2" in diameter with depressed 1/4" high black-filled letters above 1/3" blackfilled numbers shall be fastened securely at specified locations.
- D. All electrical conduits, which are accessible for maintenance operations, shall be identified with semi-rigid identification markers similar to those specified above.
- E. Each marker background is to be color-coded with a clearly printed legend to identify the conductor. Size of markers and sizes of lettering to generally conform to the "Scheme for Identification of Piping Systems" (ANSI A 13.1 - 1981)
- F. Locations for pipe and electrical markers to be as follows:
 - 1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
 - 2. Each branch and riser take-off.
 - 3. Each pipe passage through wall, floor and ceiling construction.
 - 4. Each pipe passage to underground.
 - 5. All horizontal pipe runs-marked every 25 feet.

END OF SECTION

SECTION 10522 - FIRE EXTINGUISHERS, ~~CABINETS~~, AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of fire extinguishers, cabinets, and accessories as indicated on Drawings and Schedule.
- B. Types of products required include:
 - 1. Fire extinguishers.
 - 2. Fire extinguisher cabinets.
 - 3. Mounting brackets.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

- A. Fire Extinguishers: Refers to units which can be hand carried, as opposed to those which are equipped with wheels or to fixed fire extinguishing systems.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01340 – Shop Drawings, Working Drawings, and Samples covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit product data for each type of product included under this Section.
 - 2. For fire extinguisher cabinets, include roughing-in dimensions and details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style and door construction, and panel style and materials.
 - 3. Submit samples of each required finish for verification purposes. Prepare samples on metal of same gauge as used for actual production run. Where normal color variations are to be expected, include two or more units in each sample set showing limits of such variations.
 - a. For initial selection of colors and finishes, submit manufacturer's color cards showing full range of standard colors available.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain products under this Section from one manufacturer.
- B. Codes and Standards:
 - 1. UL Listed Products: Provide new, portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.
 - 2. FM Listed Products: Provide new, portable fire extinguishers which are approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher indicated and carry appropriate FM marking.
- C. Coordination: Verify that fire extinguisher cabinets are sized to accommodate fire extinguishers of type and capacity indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Fire Extinguishers, Cabinets, and Accessories:
 - a. Amerex Corporation.
 - b. Badger Fire Protection.
 - c. J.L. Industries.
 - d. Kidd Frynetics.
 - e. Larsen's Manufacturing Co.
 - f. Potter Roemer, Div. of Smith Industries, Inc.
 - g. Accessory Specialties.
 - h. Bobrick Washroom Equipment.

2.02 FIRE EXTINGUISHERS

- A. Portable fire extinguishers shall be purchased, certified, and installed by a local supplier who has a maintenance contract on OWNER's existing installation, or can provide such a contract if none exists. Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by ENGINEER from manufacturer's standard, which comply with requirements of governing authorities. The fire extinguishers shall have a minimum 1-year warranty and shall include inspection and recharging at end of 1 year.
1. All units shall comply with Underwriter's standards. Valves shall be aluminum or brass.
 2. Extinguishers shall be red in color to conform to OSHA standards, sized as noted on Fire Extinguisher Schedule appended, and shall be made of all metal for tank, valve, and valve stem.
 3. Extinguisher shall be mounted with wall-mount bracket unless cabinets are called for on Fire Extinguisher Schedule.
 4. Fill and service extinguishers to comply with requirements of governing authorities and manufacturer's requirement.
 5. Abbreviations indicated below to identify extinguisher types relate to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.
- B. Stored Pressure Water Mist Type: UL-rated 2-A:C, 2-1/2-gallon nominal capacity, in enameled steel container with pressure indicating gauge, for Class A and Class C fires.
- C. Carbon Dioxide Type: UL-rated 10-B:C, 15-pound nominal capacity, in manufacturer's standard enameled metal container, for Class B and Class C fires.
- D. Dry Chemical Type: UL-rated 40-B:C, 10-pound nominal capacity, in enameled steel container, for Class B and Class C fires.
- E. Multi-Purpose Dry Chemical Type: UL-rated 2-A:10-B:C, 5-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.
- F. Multi-Purpose Dry Chemical Type: UL-rated 4-A:60-B:C, 10-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.

- G. Clean-Agent Type in Brass Container: UL-rated 2-A:10:B:C, 15-pound nominal capacity, in chrome plated brass container, for Class A, Class B, and Class C fires.

2.03 MOUNTING BRACKETS

- A. Provide manufacturer's standard bracket designed to prevent accidental dislodgement of extinguisher, of sizes required for type and capacity of extinguisher indicated in manufacturer's standard plated finish.
 - 1. Provide brackets for extinguishers not located in cabinets.
 - 2. Provide brackets for extinguishers not located in cabinets and for those located in cabinets, where indicated or required.

2.04 FIRE EXTINGUISHER CABINETS

- A. Provide fire extinguisher cabinets where indicated, of suitable size for housing fire extinguishers of types and capacities indicated.
- B. Construction: Manufacturer's standard enameled steel box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld all joints and grind smooth. Miter and weld perimeter doorframes.
- C. Cabinet Type: Suitable for mounting conditions indicated of the following types:
 - 1. Recessed: Cabinet box (tub) fully recessed in walls of sufficient depth to suit style of trim indicated.
 - 2. Semi-Recessed: Cabinet box (tub) partially recessed in walls of shallow depth.
 - 3. Surface-Mounted: Cabinet box (tub) fully exposed and mounted directly on wall.
- D. Trim Style: Fabricate trim in one piece with corners mitered, welded, and ground smooth.
 - 1. Trimless: For installation in walls where surface of surrounding wall finishes flush with exterior finished surface of frame and door of fire extinguisher cabinet, without any overlapping trim attached to cabinet.
 - a. Provide recessed flange, of same material as box, attached to box to act as plaster stop.
 - 2. Trimless with Hidden Flange: Of design where trim consists of perimeter flange of same metal and finish as box (tub) which overlaps surrounding wall finish and which, in turn, is concealed from view by an overlapping door.
 - 3. Exposed Trim: One-piece combination trim and perimeter doorframe overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - a. Square Edge Trim: Square edges with backbend depths as follows: 1/4 to 5/16 inch.
 - 4. Rolled Edge Trim: Rounded edges with backbend depth as follows:
 - 1) 1-1/4 inches.
 - 2) 2-1/2 inches.
 - 3) 4-1/2 inches.
 - a. Trim Metal:
 - 1) Of same metal as door.
 - 2) Enameled steel.
 - 3) Aluminum.
 - 4) Stainless Steel, ASTM A 167, AISI Type 302/304 alloy.

- E. Door Material and Construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.
 - 1. Enameled Steel: Manufacturer's standard flush, hollow-steel door construction with tubular stiles and rails.
 - 2. Aluminum: Manufacturer's standard flush, hollow-aluminum door construction.
 - 3. Stainless Steel: Manufacturer's standard door construction, fabricated from austenitic stainless steel complying with ASTM A 167, for AISI Type 302/204 alloy.
 - 4. Unbacked Acrylic: Manufacturer's standard unbacked acrylic door construction with metal edge reinforcing at hinge jamb and at latch.
 - 5. Aluminum-Backed Acrylic: Manufacturer's standard aluminum-backed, obscure-textured acrylic with silk-screen lettering or design applied to back of acrylic face.
 - 6. Door Glazing: Clear float glass complying with FS DD-G-451, Type I, Class 1, Quality q3.
 - 7. Door Glazing: Tempered float glass, complying with FS DD-G-1403, Grade B, Style I, Type I, Quality q3, class as indicated below:
 - a. Clear glass, Class 1 (transparent).
 - b. Tinted glass, Class 2 (heat absorbing), bronze tint.
 - 8. Plastic Laminate: High-pressure laminate face complying with NEMA LD-3 for GP-50; manufacturer's standard core and steel backing construction.

- F. Door Style: Manufacturer's standard design as indicated below and on Drawing.
 - 1. Full-Glass Panel: Float glass, 1/8-inch thick.
 - 2. Duo-Panel: Float glass, 1/8-inch thick unless otherwise indicated.
 - 3. Break Glass Panel: Float glass, 1/8-inch thick with inside latch and lock.
 - 4. Frameless Tempered Full-Glass Panel: Tempered float glass with polished edges and inside surface etched with lettering or design indicated and frosted.
 - 5. Solid Panel: Full flush opaque panel of material indicated.
 - a. Provide silk-screen lettering or design as indicated.
 - 6. Full-Acrylic Panel: Frameless, 1/2-inch thick clear acrylic.
 - 7. Bubble Type: One-piece molded clear plastic.

- G. Door Hardware: Provide manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide either lever handle with cam action latch, or door pull, exposed or concealed, and friction latch. Provide concealed or continuous type hinge permitting door to open 180 degrees.

2.05 FACTORY FINISHING OF FIRE EXTINGUISHER CABINETS

- A. Comply with NAAMM, "Metal Finishes Manual," for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect cabinets with plastic or paper covering prior to shipment.

- B. Painted Finishes: Provide painted finish to comply with requirements indicated below for extent, preparation, and type:
 - 1. Extent of Painted Finish: Apply painted finish to both concealed and exposed surfaces of cabinet components, except where other than a painted finish is indicated.
 - 2. Color: Provide color or color matches indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors.
 - 3. Preparation: Clean surfaces of dirt, grease, and loose rust or mill scale.
 - 4. Baked Enamel Finish: Immediately after cleaning and pre-treatment, apply cabinet manufacturer's standard baked enamel finish system to the following surfaces:
 - a. Interior of cabinet.

- b. Exterior of cabinet except for those surfaces indicated to receive another finish.
 - 5. Field Paintable Factory Finish: Immediately after cleaning and pre-treatment, apply to surfaces indicated below manufacturer's standard factory-applied paint system which is suitable, after deglossing, as an undercoat for field-applied paint system specified in Section 09900.
 - a. Exterior of cabinet, except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet.
- C. Anodized Aluminum Finishes: Provide architectural anodic coatings complying with the following requirements:
 - 1. Class II Clear (Natural) Anodized Finish: AA-M12C22A31 (mechanical finish, nonspecular as fabricated; chemical etch, medium matte; 0.4 mil minimum thick, clear anodic coating).
 - 2. Class I Color Anodized Finish: AA-M12C22A42 (mechanical finish, nonspecular as fabricated; chemical etch, medium matte; 0.7 mil minimum thick, integrally deposited colored anodic coating).
 - 2.
 - a. Provide color matching ENGINEER's sample, or if none established, as selected by ENGINEER from within standard industry colors and color density range.
- D. Stainless Steel Finish: AISI No. 4 polished finish. Furnish with paper masking to protect finish.
- E. Obscure Acrylic Colors: Provide color or combination of colors selected from manufacturer's standard colors.
- F. Plastic Laminate Colors: Provide color, finish, and pattern indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install items included under this Section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.
 - 1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
 - 2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.
 - 3. Where exact location of surface-mounted cabinets and bracket-mounted fire extinguishers is not indicated, locate as directed by ENGINEER.
 - 4. Mount bracket-mounted fire extinguishers weighing 40 pounds or less at 4'-6" above finish floor to the top of the fire extinguisher; for those weighing more than 40 pounds, at 3'-6" above finish floor to the top of the fire extinguisher.

3.02 IDENTIFICATION

- A. Identify existence of fire extinguisher in cabinet with lettering spelling "FIRE EXTINGUISHER" applied to door by process indicated below. Provide lettering to comply with requirements indicated for letter style, color, size, spacing, and location, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard arrangements.
 - 1. Application Process:
 - a. Silk Screen.

- b. Engraved.
 - c. Etched.
- B. Identify bracket-mounted extinguishers with red letter decals spelling "FIRE EXTINGUISHERS" applied to wall surface. Letter size, style, and location as selected by ENGINEER.

FIRE EXTINGUISHER SCHEDULE

Room No.	Location	Bracket	Cabinet	Type and Quality				Remarks
				Clean Agent 2A-10BC	Dry Chemical 4A-60BC	CO ₂ 10BC-15	Water-Mist 2A-C	
	Number and location as indicated on drawings	X				X		

END OF SECTION

SECTION 11311 - POSITIVE DISPLACEMENT PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for the fabrication production, installation, and erection of the items specified in this Section as shown on Drawing or listed on Schedule.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.
- C. Products Furnished But Not Installed Under This Section: Anchor bolts shall be installed under Section 03310 in accordance with certified prints furnished by equipment manufacturer.

1.02 SYSTEM DESCRIPTION

- A. Pumps in this Section are part of the Biosolids Dewatering and Handling System as specified in Section 13195.
- B. Performance Requirements: Biosolids Dewatering and Handling System supplier is responsible for pump capacity, horsepower and total discharge head necessary to meet the performance requirements of Section 13195.

1.03 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ANSI Class 125 flange dimensions.
 - 2. 316 Stainless Steel.
 - 3. ASTM A 36, Structural Steel.
 - 4. ASTM A470/A470M
 - 5. Hydraulics Institute Standards.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.
- B. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Rotary Lobe Sludge Pumps:
 - a. [Alfa Laval](#).
 - b. [Swaby Lobeline](#).

2.02 EQUIPMENT

- A. The pump shall have capacities and duty points as shown on Schedule.

2.03 COMPONENTS

- A. Motors: Motors shall comply with all requirements of Section 01600 and Section 16220 and shall be as described on Schedule. Pump motor nameplate horsepower shall be sufficient for non-overloading operation at the maximum flow rate and head listed on Schedule, including horsepower requirement of the drive. Brake horsepower shall not exceed 85 percent of the motor nameplate horsepower multiplied by the motor service factor at the specified maximum flow and head.
- B. Variable Speed Drives: Drives shall be as listed on Schedule and shall be as specified in Section 16151.
- C. Rotary Lobe Sludge Pumps: Sludge pumps shall be of the heavy-duty type, trilobe rotary positive displacement type, capable of rotation in either direction and able to run dry for an indefinite period of time. The pump and drive assembly shall be mounted on a common steel baseplate sufficiently reinforced to resist shock loads that may occur during operation.
1. The casing shall be constructed of ductile iron conforming to ASTM A 36 with a hardness of 140 to 190 Brinell. The front cover shall be case hardened to 700-750 Brinell and have a flush surface to eliminate the possibility of rag accumulation or agglomeration of material in any recesses.
 2. The cover shall be capable of being removed and replaced, and access to the entire pumping chamber shall be readily accessible without disturbing any packing glands, bearings, suction, or discharge hardware.
 3. The case shall be of side suction and discharge port design with flanged ANSI connections.
 4. Rotors: The rotors shall be trilobe form covered with replaceable urethane rubber of 90-degree shore hardness, attached to the shafts by means of a locking assembly having internally and externally expanding locking rings spread apart by axially acting taper elements secured together by a number of screws. Radial location of the rotors shall be by means of involute splines for correct rotor meshing. The complete locking assembly shall be encapsulated within the core of the rotor by the front-sealing flush disc and at the rear by means of the O-ring seal to the replaceable gland sleeve.
 5. Shaft: The shafts shall be of carbon steel conforming to ASTM [A 293](#) and shall be sufficiently large in diameter to safely transmit the maximum torque developed by the drive unit. The shaft shall be provided with replaceable stellite coated stainless steel or 440C stainless steel (minimum Brinell Hardness of 500) sleeves extending through the stuffing box. Shaft rotation timing shall be provided by straight cut, zero backlash timing gears which are keyed to the shafts. The timing gears shall run in the oil-filled bearing housing.

6. Bearings: Bearings shall be heavy-duty antifriction roller bearings with a minimum B10 life of 100,000 hours. The bearings shall run in an oil-filled, foot-mounted cast iron gear case. The case shall have an oil fill breather connection, a bull's-eye type oil level sight glass and a plugged drain connection at the low point. Shafts shall be equipped with lip type oil seals.
7. Stuffing Box: The pump shall be equipped with 2 packed, water flushed, stuffing boxes. The stuffing box shall consist of at least 4 rings of graphite packing, Teflon lantern ring and a cast iron split gland. The packing shall be suitable for bi-directional rotation.

2.04 ACCESSORIES

- A. OVER PRESSURE PROTECTION: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve. The switch shall be SPDT, NEMA 4.
- B. Rotary Lobe Pump Spare Parts: One set of rotors and an O-ring cover gasket shall be furnished as spare parts for each pump listed on Schedule.

2.05 SOURCE QUALITY CONTROL

- A. Shop Tests: Prior to shipment, the complete pump, motor, and drive shall be given a factory mechanical test to assure mechanical integrity and to check for proper operation with particular attention to gears, bearings, and drive alignment. During these tests, general performance shall be verified as defined in these Specifications. The unit shall be shipped as tested, as one fully assembled package.
 1. The standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.
 2. In case the pumps are tested separately from the motors, CONTRACTOR shall furnish certified characteristic curves of the motors to be furnished as guaranteed by motor manufacturer. These characteristic curves shall be obtained either from actual tests of the motors to be furnished or from tests of motors of the same size and type of construction.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment furnished and installed under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.

3.02 FIELD QUALITY CONTROL

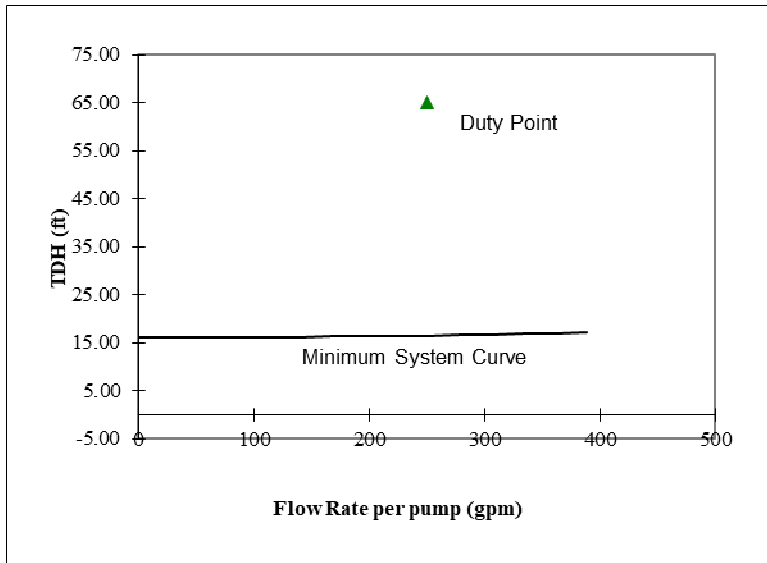
- A. Performance Tests: After the pumping units have been erected, performance tests shall be conducted. The purpose of these performance tests shall be to demonstrate that the units have been properly erected, and that they and their appurtenant equipment will operate satisfactorily and meet the specified conditions and the guarantees of CONTRACTOR. For the purpose of these tests, OWNER

will furnish the electricity, lubricating oil, and the water for a test load when these items are available. The measurement of the quantity of water pumped may or may not be included in the performance test. The performance tests shall be conducted under the supervision of ENGINEER with the cooperation of manufacturer's factory representative. It is intended that these tests shall be carried out by operating each pumping unit through the range specified for a continuous period of at least 2 hours, or until it is shown to the satisfaction of ENGINEER that all of the equipment is in perfect condition and will meet the requirements specified. Throughout these tests of the pumping equipment, the motors and pumps must run smoothly without vibration or heating, otherwise the test shall be stopped and not again undertaken until the unit shall have been put into condition to comply with the requirements for smoothness of operation.

- B. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted under Section 01600.

POSITIVE DISPLACEMENT PUMP SCHEDULE

No. of Units:	2
Type:	Rotary Lobe
Service	
Material:	Waste Activated Sludge
Concentration:	0.5% to 3%
Location:	Filter Building
Capacity Range (gpm) Minimum:	50
Capacity Range (gpm) Maximum:	250
Discharge Head (psi) Minimum:	10
Discharge Head (psi) Maximum:	65
Range of Static Suction Head (feet):	1' to 18'
Type of Speed Variation:	VFD
Pump rpm Maximum:	250
Motor Description:	460/3/60
Remarks:	<ol style="list-style-type: none">1. Pump shall be submitted VFD per the requirements of the contract documents2. Pump discharge capacity is oversized to allow for clearing of plugs in piping system and handling high percent solids sludge.3. Min Horsepower 10 hp



END OF SECTION

SECTION 13195 - BIOSOLIDS DEWATERING AND HANDLING SYSTEM (FOR REFERENCE ONLY
EQUIPMENT HAS BEEN OWNER PROCURED)

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Complete system responsibility for Biosolids Dewatering and Handling System, as specified in this and related Sections, shall be provided by one manufacturer including design, performance requirements, labor, materials, and equipment necessary for fabrication and production, for the installation, and erection as shown on Drawings or listed on Schedule. The Biosolids Dewatering Handling System shall be supplied and operated as one entity to ensure proper integration and compatibility of all system components, beginning at the feed pump and ending at the dumpster loading conveyor. All controls and programming required to integrate the system with OWNERS plant operation system, commissioning, performance testing, operator training and all warranty repairs of the complete system shall also be included. Major system components are:
1. Feed Pump and feed flow meter.
 2. Polymer blending / feed system.
 3. Screw Press with ancillary compressed air system related polymer solution injection / mixing components.
 4. Screw conveyors.
 5. Associated controls for all the equipment above.
 6. Miscellaneous equipment supports and hardware.
- B. Products Furnished But Not Installed Under This Section: Anchor bolts shall be installed under Division 3, in accordance with certified prints furnished by the equipment manufacturer.
- C. Related Sections:
1. Section 09900 - Painting
 2. Division 13 – Special Construction (Instrumentation related sections only)
 3. Section 11311 – Positive Displacement Pumps
 4. Division 16 - Electrical
- D. Alternates: Design of equipment shown on Drawings is based on Huber Technology, Inc. Alternative manufacturers will not be accepted. Refer to Appendix for Huber Technology, Inc. Proposal and scope of supply.

1.02 REFERENCES

- A. Reference Standards:
- | | |
|-----------------|---|
| 1. AFBMA 9-90 | Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings |
| 2. AFBMA 11-90 | Load Ratings and Fatigue Life for Roller Bearings |
| 3. ASTM A 36 | Steel. |
| 4. ASTM A322 | Carbon and Alloy Steel Bar Specifications |
| 5. ASTM A507-10 | Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold Rolled |
| 6. SSPC | Surface Preparation, Film Thickness Testing |

1.03 DEFINITIONS

- A. Interior surfaces: All surfaces of bins or silos in contact with biosolids, contained biosolids vapors, water or water vapor.
- B. Exterior surfaces: All exposed to view surfaces including weather-exposed surfaces.

1.04 SYSTEM DESCRIPTION

- A. Design Requirements. Biosolids Dewatering and Handling System shall pump, dewater, convey and deliver dewatered biosolids to dumpsters for offsite disposal. Control of the Biosolids Dewatering Handling System shall integrate with OWNERS operator interface system as described herein and shown on the Drawings.
 - 1. Contractor shall furnish a complete dewatering system including two (2) dewatering screw press, transfer conveyors, feed pump, drive motors, gear reducers, support legs, anchor bolts, polymer feed system, internal piping and wiring, controls, and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.
 - 2. Contractor shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions or other characteristics from these specifications and drawings.
 - 3. Contractor shall provide a pipe flocculator that shall provide retention time listed in Schedule.
 - a. The flocculation pipe is shown on Drawings. Final sizing and details will be determined by system supplier during shop drawing submittals.
 - 4. Contractor shall install the equipment according to instructions and recommendations of the equipment manufacturer.
 - 5. Press Feed Pump
 - a. Pumps shall be progressive cavity type. See Specification 11311.
 - b. Pump shall be controlled through a variable frequency controller (VFD) mounted in the biosolids handling system main control panel.
 - c. Pump size, and horsepower required based on pump capacity and discharge conditions as listed in Schedule and delivery piping as configured on Drawings.
 - 6. Feed Flow Meter. See Specification Section 13421.
 - 7. Polymer Blending Unit
 - a. Polymer blending unit shall be capable of taking as supplied (neat) polymer and activating it for efficient use in the dewatering process.
 - b. Unit shall mix neat polymer and dilution water from source and with characteristics as listed in Schedule with sufficient energy to allow full contact of polymer with the dilution water.
 - c. After activation, unit shall provide adequate aging time and mixing to fully activate the polymer with minimal shearing.
 - d. Neat polymer as supplied will be of the type selected by the biosolids dewatering and handling system supplier.
 - e. System supplier is responsible to size the polymer blending unit feed pump and water dilution system components to meet the range of screw feed solid noted on Schedule and to meet the polymer solution delivery requirements during start-up, shut-down and during periods of screw press operation at minimum feed loading.
 - 8. Screw Press
 - a. Press shall be a completely enclosed unit to contain spray and odors.

- b. Influent: Screw press shall be designed to continuously dewater sludge at the flow rates listed on Schedule. The influent solid concentration range, type of sludge and associated volatile fraction is as listed on Schedule.
 - c. Discharge: The screw press shall be capable of dewatering the influent sludge to the minimum solids content and minimum recovery rates over the entire range of feed rates and consistencies listed on Schedule.
 - d. Dewatering Aids: The screw press shall be designed to meet the performance requirements specified herein with the addition of polyelectrolytes dewatering aids to the influent sludge flow, all as noted on Schedule.
 - e. Compressed Air System sized support screw press operation shall be furnished.
9. Screw Conveyors
- a. Maximum trough loading of 25 percent at the speeds shown in Schedule.
 - b. Where indicated freeze protection good for -13 degrees F (-25 deg C) shall be provided for exterior mounted transfer conveyors.
 - c. All mechanical parts shall be designed for loadings exerted during fabrication, shipping, erection and during operation.

B. Performance Requirements. This specification provides brief descriptions and minimum requirements for the components and accessories of the Biosolids Dewatering and Handling System. A complete, functional system meeting the performance criteria set forth in the Schedules and as specified herein shall be provided by CONTRACTOR and manufacturer.

1.05 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
- 1. General:
 - a. Product Data: Include the following:
 - 1) Descriptive literature, brochures, catalogs, cut-sheets and other detailed descriptive material of the equipment.
 - 2) Motor characteristics and performance information.
 - 3) Gear reducer data including service factor, efficiency, torque rating, and materials.
 - 4) Parts list including a list of recommended spare parts.
 - 5) Shop Drawings: Include the following:
 - 6) Manufacturer's installation and testing drawings and instructions.
 - 7) Wiring and schematic diagrams.
 - b. General arrangement drawings of all system components.
 - c. Connection details showing incorporation of all materials and equipment into the Work.
 - d. Dimensional drawings of all system components.
 - e. Materials of construction.
 - f. PI&D diagram and interconnection wiring diagrams between all controls Electric control data.
 - g. Data for accessories to be supplied.
 - 2. Equipment weights and lifting points. Screw Conveyors:
 - a. Drive station assembly drawings.
 - b. Motor data sheets.
 - c. Component and accessory details.
 - 3. Feed Pump:
 - a. Pump data sheets indicating pump capacity, discharge pressures, stroking speed, stroking length and electrical data. See Specification Section 11311.

- B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770. Submit electronic copies of all control system logic on a CD
- C. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.
- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- E. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.
- B. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

1.07 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than five years.
- B. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.
- C. Single Source Responsibility: Obtain products under this Section from one manufacturer.
- D. Manufacturer shall provide screw press, transfer screw conveyors, feed pump, polymer system, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
- E. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.
- F. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.

- G. Each major component of equipment shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.

1.08 WARRANTY

- A. The manufacturer will warrant against any defects in material or workmanship to the screw press and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

1.09 MAINTENANCE

- A. Spare parts: the following spare parts shall be included and supplied together with the equipment:
 - 1. Screw Press
 - a. One (1) set of brushes with mounting hardware (clips)
 - b. One (1) bearing assembly for shaft
 - c. One (1) solenoid valve (1-inch, 110V, Cl.1/Div. 2 for spray wash bar washing system)
 - d. Ten (10) nozzles for spray bar washing system
 - e. One (1) spare part kit for neat polymer pump
 - 2. Control Panel
 - a. Provide standard manufacturer recommended spare parts (fuses, bulbs, etc.)
 - 3. Screw Conveyors, provide one set per screw:
 - a. One (1) complete trough liner
 - 4. Progressive Cavity Pumps: See Specification Section 11311.
- B. Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Biosolids Dewatering and Handling System:
 - a. Huber Technology, Inc.
 - 2. Air Compressor
 - 3. Polymer Blending Unit
 - a. Velodyne

2.02 MATERIALS

- A. Biosolids Dewatering and Handling System General:
 - 1. Bearings shall be anti-friction, and without the need for grease lubrication.
 - 2. Name Tags: Laminated Plastic
- B. Feed Pumps: See Specification Section 11311

- | | |
|--------------------------------------|------------------------------|
| C. Polymer Blending Unit | |
| 1. Frame: | 304 Stainless Steel |
| 2. Piping: | Sch 80 PVC |
| 3. Mixing Chamber Impeller: | 304 Stainless Steel |
| 4. Mixing Device Body: | PVC |
| 5. Mixing Chamber Cover: | Clear Polycarbonate |
| 6. Mixer Seal: | Viton |
| 7. Fasteners: | 18-8 Stainless Steel |
| 8. Control Panel: | FRP |
| D. Screw Press | |
| 1. Frame, Body and Supports: | 304L Stainless Steel Shapes |
| 2. Wedge Wire Basket: | 304L Stainless Steel |
| 3. Screw Flights and Shaft: | 304L Stainless Steel |
| 4. Fasteners and Anchors: | 304L Stainless Steel |
| 5. Spray Wash System | 304L Stainless Steel Pipe |
| 6. Brushes: | Wear Resistant Plastic |
| 7. Brush Fastening Hardware | Stainless Steel |
| 8. Control Panels | Stainless Steel |
| E. Screw Conveyors: | |
| 1. Trough Bodies, Covers, End Plates | 304L Stainless Steel Plate |
| 2. Screw Flights | 304L Stainless Steel |
| 3. Screw Shaft | 304L Stainless Steel |
| 4. Trough and Cover Liner | UHMW Polyethylene |
| 5. Fastener Hardware: | 304L or 316L Stainless Steel |
| 6. Conveyor Supports: | 304L Stainless Steel |
| 7. Insulation: | Foil Backed Mineral Wool |
| 8. Insulation Cover: | Stainless Steel |
| 9. Anchor Bolts: | Stainless Steel |

2.03 EQUIPMENT

A. General

- The screw press, screw conveyors and associated supports shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with rusty dust. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated. The equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless steel parts of the unit shall be fully submerged into a pickling bath for at least 8 hours to remove welding spots and to protect the stainless steel against corrosion. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection. Glass bead blast or chemically treated stainless steel shall not be allowed.
- All equipment electric motors shall be 480 volt high efficiency meeting requirements of Section 16220 with minimum motor horsepower and other details outlined on Schedule. Motor

nameplate horsepower shall be sufficient for non-overloading operation for all anticipated operational conditions including any horsepower requirements of the equipment drive. At no operational condition shall the required brake horsepower exceed 85 percent of the motor nameplate horsepower multiplied by the motor service factor. Variable speed drives shall meet the requirements of Section 16151.

3. Unless specified otherwise, bearing shall conform to AFBMA standards and have minimum L-10 life of 50,000 hours.

B. Polymer Blending Unit:

1. System shall be designed for the preparation, aging and dosing of polymer solution having an active polymer solution concentration as listed on Schedule.
2. The polymer station shall be self-contained with pumps, motors and controls including integral piping, fittings, pipe supports and accessories, and shall be factory assembled and tested to eliminate field assembly work and therefore to minimize installation and start up time.
3. Polymer activation and blending chamber shall be multi-stage multi-zone hydro-mechanical type with both a mechanical and non-mechanical stages. A high energy, multi zoned, hydro-mechanical mixing device with hydro mechanical impeller designed to produce variable intensity, back flow mixing action to optimize polymer performance without damaging polymer molecular structure.
 - a. Non-mechanical stage shall be capable of activating and blending polymer with minimum blending water pressure of 30 psig.
 - b. Hydro-mechanical stage shall have a controllable mixer with impeller designed for non-damaging mixing energy at all flow rates with both axial and radial elements.
 - c. A pressure gage shall be provided for polymer solution before it leaves the blending unit.
4. Mixer motor shall be 0.5 HP or the minimum listed in Schedule. Mixer assembly shall be pressure rated for 100 psi.
5. Dilution water piping shall be equipped with a pressure gage and flow meter and the dilution water flow controlled by UL listed solenoid valve (rated IP65).
6. To verify feed pump output a calibration chamber rigidly mounted to the unit frame with two full port ball valves having Viton o-rings shall be provided. Column shall be calibrated for approximately 1 minute draw down at maximum pumping rate.
7. A neat polymer metering pump integrally mounted on the systems skid shall be provided with range as listed in the Schedule. Pump shall be constructed of components compatible with type of polymer selected and have packing type seals and wash down duty rated motor compatible with variable speed control. The neat polymer pump type shall be as listed in Schedule.
8. Control Panel: NEMA 4X FRP enclosure.
 - a. Operator interface – discrete selector switch (system ON/OFF/REMOTE); mechanical mixer speed adjust potentiometer; speed adjustment at metering pump.
 - b. Status / Alarm indicators:
 - 1) System running indication.
 - 2) Power On indication
 - 3) LED display of metering pump rate (on metering pump)
 - 4) Low water differential pressure switch alarm
 - 5) Low polymer flow alarm
 - 6) General fault
 - c. Inputs:
 - 1) Remote start / stop (discrete dry contact);
 - 2) Pacing signal from main control panel (4-20mA)

- d. Outputs:
 - 1) System running (discrete dry contact)
 - 2) Remote mode (discrete dry contact)
 - 3) Common alarm (discrete dry contact)

C. Screw Press

1. The screw press shall be completely enclosed to prevent odor emission with flanged odor duct nozzles connections; one near the inlet and one near the outlet with diameter as indicated on Schedule. The whole dewatering section and basket area shall be easily accessible through an inspection lid, which is mounted via two hinges on the side of the machine.
2. A screw shall be installed inside of the screen basket. The screw transports the sludge from the inlet to the discharge area at the end of the pressure zone. Its shaft diameter shall be conical towards the discharge section of the machine. The flights of the helical screw shall be provided with brushes to clean the wedge wire screen from the inside.
3. Sludge cake shall be automatically discharged through a rectangular sludge discharge opening.
4. The screw press shall be installed inclined (at 10°). Dewatering of the sludge takes place in a basket, which consists of three sections of wedge wire baskets.
5. The screw shall be shafted and shall be made of stainless steel. A shaft-less screw is not acceptable. A bearing shall support the discharge end of the screw shaft. Wear strips are not acceptable.
6. A pneumatically actuated cone that serves for adjusting the pressure in the pressure zone shall be provided at the discharge end of the screening basket.
7. The cleaning of the wedge wire screen from the outside shall be performed with a stationary spray bar washing system made of stainless steel piping and spray nozzles. The spray area shall run the entire length of the screen. One solenoid valve shall control the flow to the spray bar washing system. If a cleaning cycle is initiated, the screw press motor reverses and rotates the basket, until has completed a 360-degree rotation ensuring the entire surface area of the screen is cleaned.
8. Drive:
 - a. The screw press shall be driven by a shaft mounted gearbox and motor assembly. The gear reducer shall be bolted to a machined flange welded to the lower end of the press.
 - b. The gear reducer shall be driven by a 1,680 rpm, 3-phase, 60 Hertz, 230/460 volt, Class 1, Division 2 continuous-duty motor with a conduit box suitable for outdoor operation. The minimum motor power shall be as listed in Schedule.
 - c. The output speed of the gear reducer shall be 1.0 rpm at frequency of 60 Hz.
 - d. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable.
9. To adjust backpressure at the press discharge high pressure air will be utilized. A 120V air compressor shall be supplied by system supplier. A pneumatic control panel equipped with solenoid valves, pressure sensors, pneumatic tubing, regulators and any other equipment necessary to control the press discharge cone shall be provided by the system supplier.
10. As part of the screw press system the manufacturer shall provide a polymer solution injection ring for mounting in the feed piping and a mixing valve with adjustable weight followers to ensure optimum mixing conditions and creating the right size and strength of flocks.

D. Screw Conveyors

1. The screw conveyor shall be designed to convey the maximum expected loading and material consistency discharged from the screw press.
2. Conveyors shall be fabricated with inlet and discharge location as shown on Drawings. Conveyors shall have constant speed, variable speed or reversing drives as indicated on the Drawings and as listed in Schedule.

3. Inlet Hopper. System supplier shall provide an inlet hopper fabricated to attach to the press discharge opening that will direct material into the conveyor. Side walls of hopper shall have minimum angle of 60 degrees from horizontal axis minimum solids accumulation.
 - a. Inspection doors shall be provided at convenient location to allow viewing of the hopper interior and for cleaning purposes.
4. Transition chutes shall be provided where conveyors connect to each other. .
5. Bolts, nuts and washers shall be selected from AISI 304L or 316L stainless steel such that they are anti-seizing
6. Electric motors, gear reducers, and other self-contained or enclosed components shall have an acrylic enamel finish.
7. Conveyor Drive
 - a. The screw conveyor mechanism shall be driven by a shaft mounted gearbox and motor assembly. The gear reducer shall be bolted to a machined flange welded to the upper end of the conveyor tube.
 - b. The gear reducer shall be driven by a continuous-duty motor with a conduit box suitable for outdoor operation.
8. Shaft diameter shall be 3.5” minimum.
9. Conveyor Trough
 - a. Each conveyor trough shall be U-shaped, fabricated from a minimum 1/8” (3 mm) AISI 304L stainless steel plate. Each trough shall be equipped with inlet and discharge connections, as indicated on the drawings. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging. .
 - b. A wear liner shall be provided for the trough and cover. The wear liner shall be made of a minimum 5/16-inch thick ultra-high-molecular-weight polyethylene. The wear liners shall be manufactured in sections with a maximum length of 4 feet to allow for easy replacement.
 - c. Trough shall be fitted with continuous bolted cover. The covers shall be manufactured in sections with a maximum of 5 foot lengths to allow for easy access
10. Conveyor Supports
 - a. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the Drawings and as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and other end of the trough plus intermediate supports at a maximum of 11 foot intervals. The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.
11. Freeze protection
 - a. All exterior portions of conveyor shall be furnished with electrical heat tracing, and thermal insulation with protective stainless steel covering which shall enclose the conveyor trough and covers.
 - b. The outdoor weather protection system shall include self-regulating heat tracing, adjustable thermostat, insulation and a stainless steel protective jacket.
 - c. The heat tracing system shall be suitable for operation down to a minimum temperature of 25 deg C (13 deg F) and shall be powered from the main control panel.
 - d. All components requiring service or maintenance shall be easily accessible.
 - e. The heat trace shall have an integral alarm that shall be monitored by the main system controls.
 - f. The components shall be furnished by Solids Handling equipment supplier and wired by Contractor.
12. Each screw conveyor shall have a zero speed switch.

13. Accessories
 - a. When called for on Schedule provide E-stop push button.
 - b. When called for on Schedule provide E-stop pull cord.
 - c. Forward-off-reverse selector switch station shall be provided if listed on Schedule.

E. Main System Controls

1. The entire control system shall be provided by the system supplier and shall consist of a main control panel, PLC, HMI, programming logic and all necessary integration between the main panel, feed pump, polymer panel, pneumatic panel and all ancillary push button stations and E-Stops.
2. One stainless steel main control panel with NEMA 4X enclosure shall be provided.
3. System operation shall be preprogrammed to operate automatically in three modes:
 - a. Stop and Start initiated at the main control panel HMI
 - b. Start time with automatic run until the input volume of sludge is processed.
 - c. Timed operation based on operator adjustable start-stop times.
4. Automatic discharge routines shall be provided for control of dumpster discharge:
 - a. Manual control of discharge location.
 - b. Timed operation into dumpsters with reset after time out to minimize overfilling.
 - c. "Top-off" mode with operator selected time period to complete dumpster fill.
 - d. Automatic switch over between dumpsters after adjustable run time.
5. A 460-volt main control panel shall be provided in a NEMA 4X rated stainless steel enclosure. The enclosure shall be suitable for wall mounting, shall have hinged covers which swing horizontally and shall be held closed with mechanical spring loaded fasteners.
 - a. Main power disconnect switch (pad-lockable)
 - b. Control power transformer
 - c. Surge arrester
 - d. H-O-A control switches (screw drive including F/R selector switch, thin sludge pump, wash water solenoid valve)
 - e. Feed pump VFD and screw conveyor motor starters.
 - f. Programming for feed pump suction control based on 4-20mA input level signal from the east and west sludge storage tanks. Controls as minimum shall include:
 - Low Level Alarm
 - Low Level Cut Off
 - Pump Off
 - High Level Alarm
 - Manual Operator Select Source Tank – East or West
 - Display of Selected Tank Level (for operator reference)
 - g. Screw press main drive VFD. =
 - h. Programmable logic controller (PLC) Allen Bradley Compactlogic with control net bridge and on-board Ethernet
 - i. Operator Interface (OIU), Allen Bradley Panelview touch 1000 with color touch screen and ethernet communication
 - j. As a minimum screw press controls will display include operator input and adjustment the following parameters:
 - Feed pump rate adjustment in gpm
 - Polymer solution feed rate in gpm
 - Automatic polymer flow pacing
 - k. Running time meter for screw press, and feed pump
 - l. Text screen message displays for important system parameters.

- m. Operating and warning lights for the following
 - Power ON
 - Dewatering System in operation
 - System general fault
 - Screw conveyor heat tape fault
 - Reset button
- n. Laminated plastic nametags shall be provided for the name of the control panel and all disconnects, switches, lights, and meters
- o. Spare terminals (control- and power voltage) shall be provided to accommodate for remote control operation and to interface with other equipment components such as the polymer dosing system, feed pumps, pneumatic control panel, etc

2.04 FABRICATION

- A. Shop Assembly. All equipment and materials provided shall be factory assembled and finish painted to the extent possible and practical before shipment.

2.05 FINISHES

- A. Shop Priming and Finishing.
 - 1. Surface Preparation. Prior to priming in the shop, all surfaces shall be cleaned of all rust, mill scale, dust, as well as other interference materials. The removal of these items shall be accomplished by sandblasting in accordance with SSPC Surface Preparation Specification No. 10 on the interior plates and SSPC- SP6 on the exterior plates.
 - 2. Priming. After surface preparation as set forth above, all surfaces shall be thoroughly and completely cleaned of any residue or dust before applying primer. Prime coat shall be applied immediately after surface preparation and before any deterioration of surface can occur. The interior prime coat shall be applied to a minimum dry film thickness of 3.0 - 5.0 mils to within 2 inches of the edge of the plates, or surfaces. The exterior prime coat for surfaces receiving finish coats of acrylic polyurethane shall be applied to a minimum dry film thickness of 3.0 - 5.0 mils to within 2 inches of the edge of the plates, or surfaces. The exterior prime coat for surfaces receiving an epoxy finish coat shall be applied to a minimum thickness of 2.0 - 3.5 mils to within 2 inches of the edge of the plates, or surfaces.

2.06 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. All conveyors shall be factory assembled for fit and, when practical, run dry prior to being shipped. All components shall be checked for fit prior to disassembly and preparation for shipment.
 - 2. Prior to shipment, each screw press shall be fully tested to the extent practical at the manufacturer's plant.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer's Qualifications: Firms specializing and experienced in systems installations for not less than five years.

3.02 EXAMINATION

- A. Examine areas and conditions under which equipment is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.03 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.
- B. After Installation touch-up paint shall be applied to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall passivate all field welds.

3.04 FIELD QUALITY CONTROL

A. General:

1. Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.
2. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600.
3. Manufacturer shall provide services by a factory-trained service engineer, specifically trained on the type of equipment specified, for two (3) trips including (8) days to inspect the installation, carry-out the equipment start-up procedures, and provide training to the operators in how to effectively operate and maintain the equipment. Service engineer requirements include, but are not limited to the following:
 - a. Service engineer shall be present during initial energizing of equipment to determine directional testing.
 - b. Service engineer shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
 - c. Service engineer shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
 - d. Manufacturer shall state field service rates for a service engineer to Owner and Contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment in to operation, additional time shall be purchased by contractor to correct deficiencies in installation, equipment, or material without additional cost to owner.
4. Site Performance Tests: After the equipment has been installed, performance tests shall be conducted. The purpose of these tests is to demonstrate the equipment is functioning properly and that dewatered sludge solids, solids recovery, and polymer use are within the limits described under operation requirements on Equipment Schedule.
 - a. For the purpose of these tests, OWNER will furnish the electricity, lubricating oil, and the water for a test load when these items are available. The measurement of the quantity of water pumped may or may not be included in the performance test.
 - b. The performance tests shall be conducted under the supervision of ENGINEER with the cooperation of the manufacturer's factory representative.
 - 1) The performance testing shall consist of two (2) steady-state 3-hour test runs. Feed sludge, dewatered sludge, and filtrate samples shall be taken at the beginning of the

test period and each hour thereafter for a total of 4 samples of each type for each run period. Samples shall be stored in airtight containers until all are collected. The four samples shall be thoroughly mixed together and the total aggregate sample quartered. A sample from each quarter shall be taken and tested, and the four results averaged to the nearest 0.1 percent Total Solids. This shall be the test result of one test run. The feed solids for each test run must vary by at least 1.5% so two points on the machine throughput curve can be obtained. Performance test runs may need to be separated by several days to allow enough time for OWNER to thicken the feed solids as required.

- 2) No adjustments will be allowed in sludge feed rate, polymer dosage, screw speed, inlet feed pressure or cone pressure during each of the actual testing/sampling periods. Testing and sampling procedures may be modified prior to actual testing with the agreement of OWNER, ENGINEER, and equipment manufacturer.
 - 3) OWNER will supply the polymers based on screw press manufacturer recommendation provided it is available from the plants local polymer supplier. If a manufacturer wishes to use other polymers (than available locally) in an effort to optimize performance, they must be provided by manufacturer at no cost to OWNER. OWNER will provide all laboratory testing services.
- c. The equipment will not be accepted until a satisfactory test has been run. Upon completion of a satisfactory equipment test, complete certificate of component acceptance form in Section 00625.
5. Operation and Maintenance Training: Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
 6. Schedule training with Owner, provide at least 7-day prior written notice to ENGINEER

POLYMER FEED SYSTEM SCHEDULE

Number of Units:	2
Location:	Biosolids Handling Facility
Type of Feed Pump:	Progressing Cavity
Polymer Type:	Emulsion
Viscosity (cp)	2,000 to 6,000
Active Solids (percent):	35 to 55 %
Feed Pump Rate Adjustment:	Automatic
Feed Pump Rate	
Max (gph):	5
Min (gph):	0.3
Target Solution Concentration of Neat Polymer	
Minimum (percent):	0.2
Maximum (percent):	0.4
Solution Concentration Adjustment:	Manual
Dilution Water Type:	Plant Effluent Water
Dilution Water Feed:	
Max (gpm):	20
Min (gpm):	2
Motor Description:	Min 0.5 HP, 120/1/60

Remarks:

Feed pump and dilution water rates and are approximate only. System supplier responsible for sizing.

SCREW PRESS SLUDGE DEWATERING EQUIPMENT SCHEDULE

Number of Units:	2
Location:	Biosolids Handling Facility
Influent:	Waste Activated Sludge
Solid Concentration Range	0.5-3 %
Volatile Fraction (percent):	60 - 70 %
pH	6.5 – 7.5
Flocculation Pipe	
Minimum Retention Time (seconds):	40
Flow Rate (gpm):	150
Loading Rates (not including polymer addition)	
Maximum:	60 gpm @ 3.0% TSS
Minimum:	150 gpm @ 0.5% TSS
Machine Thru-put	
Maximum:	900 lb/hr
Minimum:	375lb/hr
Motor Description:	5 HP, 460/3/60
Dewatering Aids:	Polymer
Max Polymer dosage	22 lb active/dry ton solids
Minimum Dewatered Solids Concentration	16%
Average Dewatered Solids Concentration	17%
Minimum Solids Capture efficiency	95%
Odor Duct Connections:	2 - 6" with blind flanges

END OF SECTION

SECTION 13410 - BASIC INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for instrumentation installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 1.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each product specified.
 2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
 3. Digital Systems: Provide the following:
 - a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.
 4. Software Programs: One fully annotated printed copy of program prior to factory test. In addition, provide required number of copies of latest revisions of program at time of acceptance by OWNER. Submittal of printouts, listings, and screen images shall be supplied on paper (hard copy). With concurrence of OWNER and ENGINEER, machine readable magnetic copies may be supplied in addition to printed copies as a matter of convenience. Format of magnetic media shall be as mutually agreed with OWNER.
 5. Programmable Logic Controllers: Submits lists of input and output assignments, data file structures used, and internal data points. Show points used to communicate with between PLCs and the operator interface and data collection segments. Include complete, fully annotated ladder logic diagrams complete with cross-reference listings.
 6. Operator Interface and Supervisory Control: Submit "screen dump" images of each proposed operator interface screen. Describe color schema, mouse button use, function key controls and communication protocol with PLCs. Provide a flow diagram showing screen navigation. Show sample event and alarm log outputs.
 7. Data Collection: Submit details of data structures, communications protocols, data exchange formats, sampling intervals, and file storage space management. Provide "screen dump" images of historical trending.
 8. Data Management and Reporting: Includes process data management, laboratory management, and reporting. Submit data definitions, customization of base software, data entry screens, menus, and report formats. Describe data entry, collection, and reporting scenarios. Describe data file storage management including backup and archive operations.
- B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
1. Where Drawings are drafted by computer equipment, CONTRACTOR shall furnish files on a disk. These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.
 2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.

- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
 - 1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.
 - 2. Provide 1 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment.
 - a. Include complete software manuals for operating system, as well as manuals for any other software. Written instructions for the operations and maintenance of software shall be provided. The instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating software.
 - b. Include program listings, point/address lists, cross-reference listings, images of screens, data entry forms, and sample reports.
 - c. Manuals shall include instructions for program users and instructions for maintenance programmers.
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. National Electric Code.
 - 2. Applicable State and local requirements.
 - 3. UL listing and labeling shall be adhered to.
- C. Items covered by this Section are designated as undelivered specifically manufactured equipment for which associated progress payments will be made in accordance with this Specification.
- D. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.
- E. CONTRACTOR shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the Work is done. CONTRACTOR shall pay fees for permits, inspections, licenses, and certifications when such fees are required.
- F. To ensure timely performance and conformance with Specifications, Project meetings shall be held at OWNER's facility once every 3 months during course of Project. Cost of such meetings shall be included.

- G. Calibration Equipment and Testing Apparatus: Equipment supplier shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes.
1. The equipment required for these tests is as follows:
 - a. One - Digital Multimeter with an accuracy of plus or minus 0.1 percent.
 - b. One - Signal calibrator for analog signals.
 - c. One - 60-inch Water Manometer with 0.1-inch graduations. Include accessories of floor stand, pipe clamp, tubings, air bulb with shutoff and fittings for 0.25 inch and 0.375 inch threaded taps for "Tee" fittings to connect manometer.
 - d. One - Set of portable radios capable of operating within buildings at one location and 5 miles outside of buildings in hilly terrain.
 - e. One - Programming terminal with software to configure programmable equipment.
- H. Component Requirements: For the purposes of uniformity and conformance to industry standards, signal transmission modes shall be either electronic 4-20 mA DC or pneumatic 3-15 psi only. No other signal characteristics are acceptable, except for remote temperature detector (RTD) and thermocouple (TC) sensing circuits; 4-20 mA DC signals shall be such that devices may be wired in parallel for 1-5 volt DC as required. 1-5 volt DC mode shall be employed only within control panel enclosures.
- I. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONTRACTOR shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of ENGINEER with or prior to submittal.
- J. CONTRACTOR shall be responsible for costs incurred to correct aforementioned errors brought to ENGINEER's attention. CONTRACTOR shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.
- B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR. Repair and replacement of damaged parts will be done at no expense to OWNER.
- C. CONTRACTOR shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPLIERS

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):
 - 1. Commerce Controls
 - 2. CEC Controls
 - 3. Perceptive Controls
- 4. PAC Engineering

- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by ENGINEER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.

- C. Equipment Supplier: Equipment specified under Sections 13413 through 13899 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
 - 1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by ENGINEER.
 - 2. Direct purchase of any items in these Sections by CONTRACTOR is not in compliance with this Specification and will not be permitted.
 - 3. When a Service Contract is included, it shall be performed by factory-trained personnel employed by equipment supplier. Equipment supplier shall assign a qualified Engineer employed by the supplier as Project Engineer/Project Manager.
 - a. Project Engineer/Project Manager's name shall be forwarded to CONTRACTOR and ENGINEER within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 EQUIPMENT

- A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.

- B. Enclosures shall be NEMA 1, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.

- C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.

- D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what circumstances and

locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.

- E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.
 - 1. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.
- F. Size and style of instruments are defined in Specifications. Pneumatic panel-mounted units shall match in appearance similar electronic components.
- G. Charts and scales are shown on Drawings. Standard scales shall not be accepted without ENGINEER's approval if it differs from those shown. Ratio station scales and other scales shall be graduated such that major graduations fall on whole numbers (i.e., 1, 2, 3, or 5, 10, 15, etc.) and minor graduations fall on 0.1 or 0.2 intervals (i.e., 1.1, 1.2 or 11, 12, etc.). If two scales are called for on ratio stations, each scale shall be indexed to meet Specification. Drawing of each scale for ratio stations shall be submitted with Shop Drawings for approval.
- H. Solid-state output switches, where used, shall be overvoltage transient protected and not be damaged by dI/dT or dv/dt for their design application under this Contract.
- I. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field- and panel-mounted devices. Tags shall include ENGINEER's tag identification and manufacturer's tag identification if different from ENGINEER's.
 - 1. Tags shall be either stamped metal or laminated phenolic with white letters engraved on a black background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.
- J. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.
- K. Provide equipment identification nameplates complying with Section 16075. Nameplates shall contain ENGINEER's item designation and, for indicators and transmitters, design range and units of device shown.

2.03 SOURCE QUALITY CONTROL

- A. Control and monitoring system control panels and computer equipment, if any, shall be tested at the factory and witnessed by ENGINEER prior to shipment to Site. ENGINEER shall be given 4 weeks notice before factory test date. Factory test shall include checking for conformity to Specifications, fabrication, and nomenclature. Control and monitoring system logic and terminals shall be checked line by line and function by function in total for conformity of Drawings.
- B. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface with programs. Verify correct communications.

- C. Factory testing shall be used to validate fieldbus and plant LAN/WAN interconnections. Proper communication between devices and software components shall be demonstrated. Data Collection and Data Management Reporting shall be demonstrated.
- D. Equipment supplier shall have test equipment available at the factory. A full set of annotated logic programs and wiring diagrams with the latest revisions shall be made available to ENGINEER at factory for checking purposes. Drawings shall include wire numbers and terminal numbers.
- E. Control panels and programmable equipment shall not be shipped to Site until logic conforms to Contract requirements, physical changes required by testing are made, and tags conform to factory test corrections. Equipment delivered to Site without factory test or corrections will be returned to factory at CONTRACTOR's expense.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.
- B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.
- D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.
- E. Drawings are not intended to show every detail of construction or location of piping, ductwork, or equipment. Where proper operation or construction makes it necessary or advisable to change location of piping, instrumentation equipment, air ducts, or other equipment, CONTRACTOR shall so inform ENGINEER for his approval and permission.

3.02 FIELD QUALITY CONTROL

- A. Calibrate equipment in accordance with manufacturer's instructions to ranges or set points indicated on Drawings.
- B. Installation and Start-up: Equipment supplier shall have an established service facility from which qualified technical service personnel and parts may be dispatched upon call. Such a service facility shall be no more than 6 hours travel time from Site.
 - 1. Equipment supplier shall provide an experienced, factory-trained, competent, and authorized service representative for a minimum of 3 times at Site, including once during installation and start-up and once during acceptance to inspect, check, and calibrate any part of system. Supplier's service representative shall revisit Site for 8 hours per day as often as necessary after installation until trouble is corrected and equipment has passed acceptance test and is operating satisfactorily to ENGINEER.

2. Third trip is after equipment has been accepted and shall be used to instruct OWNER's personnel in aspects of operation and maintenance, such as fuse locations, use of controls, instruction manuals, etc. Third trip shall be for duration of two, 8-hour days at OWNER's facility.
- C. Equipment supplier shall provide two, 8-hour days of training for OWNER's personnel in aspects of operation and maintenance such as use of controls, fuse locations, instruction manuals, etc.
1. Training and instructions at the plant shall be given by the Project Engineer assigned to the Project by the equipment supplier or other personnel as approved by ENGINEER.
- D. Digital Equipment Field Training: At conclusion of field acceptance tests, CONTRACTOR shall conduct a training course for OWNER's personnel in use of system.
1. Course shall be 2 weeks duration and shall consist of hands-on use of system as well as lectures.
 2. Written course materials shall be provided to each participant for use during instruction and to serve as a basic reference document after training.

3.03 DEMONSTRATION

- A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

END OF SECTION

SECTION 13413 - OPTICAL FIBER CABLING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Product and installation requirements for the following:
1. Fiber-optic (FO) Cables.
 2. Fiber-optic Connectors, Couplers, and Patch Panels.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each type of product specified.
 2. Product certificates, signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" Article below.

1.03 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Connected Equipment Manufacturer Certifications: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.
- C. UL Compliance: For cables that may be run in plenum ceilings or other air-handling spaces, provide cables tested for compliance with applicable requirements of UL Standard 910, "Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces." In addition, provide FO cables that have passed the UL VW-1 flame test.
- D. EIA/TIA Compliance: Comply with applicable requirements of EIA Standards, EIA-440, -455, -458, -475, -509, -568-b.3, and 598-a pertaining to optical fiber cable and system component construction and installation. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.
- E. Fiber Optics Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of fiber-optics cable systems. Installation must include installation of fiber-optics cable, fiber termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- F. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in

sequential order, for all workstations or devices attached. Each fiber-optics cable segment shall be labeled at each end with its respective identifier.

- G. Fiber-Optics Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all fiber cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All fiber-optics interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- H. Patch Cords: Patch cords shall be provided for each fiber-optic port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed fiber-optic cable. Patch cord connectors shall be matched with patch panel connector type and network fiber module connector type as required.

1.04 COMMISSIONING

- A. Subsequent to hook-ups of FO system to signal sources and destination equipment, operate systems to demonstrate proper functioning. Replace malfunctioning FO cabling system items with new materials, and then retest until satisfactory performance is achieved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. FO Cables:
 - a. Corning Infinicor SX+ Optical Fiber, or Equal, for multi-mode applications.
 - 2. FO Connectors and Couplers:
 - a. AMP Netcon.
 - b. AT&T Network Systems.
 - c. Corning.
 - d. Honeywell, Inc.
 - e. ITT Corp.
 - f. Thomas and Betts Corp.
 - 3. FO Patch Panels:
 - a. Panduit.
 - b. Volition.

2.02 OPTICAL FIBER CABLING SYSTEMS

- A. Fabricate system using manufacturer's standard materials as indicated by published product information and in sizes, types, and performance characteristics as indicated.
- B. FO Cables: Factory fabricated, single channel, all dielectric, low loss glass type, fiber-optic multimode graded-index cables with the following operational and construction features:
 - 1. Multi-mode Fibers:
 - a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Core Diameter: 50 microns or as listed on Drawings.

- d. Cladding Diameter: 125 microns or as listed on Drawings.
 - e. Subunit Size: 2.0 mm or as listed on Drawings.
 - f. Maximum Attenuation: Less than 2.5 dB/850 nm.
 - g. Minimum Bandwidth: Greater than 500 MHz-km.
 - h. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - i. Operating Temperature Range: -20 to +70 degrees C.
- C. FO Connectors: Stainless steel, fiber-optic cable connectors, capable of terminating FO glass cables with diameters from 8 through 1,000 microns. Fabricate connectors with optical fiber, self-centering, axial alignment mechanisms. Select ST or SC style connectors as required or shown on Drawings. Connectors shall have an insertion loss of 0.5dB or better.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions with the Installer present for compliance with requirements, and other conditions affecting the performance of optical fiber cabling system. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION

- A. Install fiber-optic cables and associated equipment and devices in accordance with industry standards and manufacturer's written instructions.
- B. Install fiber-optic cable without damage to fibers, cladding, or jacket. Ensure that media manufacturer's recommended pulling tensions are not exceeded. Do not, at any time, bend cables to smaller radii than minimums recommended by manufacturer.
- C. Install FO cables simultaneously where more than one cable is being installed in same raceway. Use pulling lubricant where necessary; compound used must not deteriorate cable materials. Do not use soap. Use a pulling means, including fish tape, rope, and basket-weave grips, that will not damage media or raceway.
- D. No splices are allowed, except at indicated splice points.

3.03 GROUNDING

- A. Provide grounding connections for other system components as required by manufacturer's written instructions.

3.04 APPLICATIONS

- A. Install optical fiber cabling for project applications as detailed on drawings.

3.05 FIELD QUALITY CONTROL

- A. Testing: Testing shall be done by CONTRACTOR with at least 5 years of experience in testing fiber-optic cabling systems. CONTRACTOR shall test each fiber strand. **OWNER reserves the right to have representation present during all or a portion of the testing process.**

CONTRACTOR must notify OWNER 5 days prior to commencement of testing. If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER. Any fiber-optic cable left non-terminated at the discretion of OWNER, shall be tested using an adequate light source to determine that all installed strands are not damaged.

- B. Fiber-Optics Cable: Each fiber strand shall undergo bi-directional testing for signal attenuation losses using power meter and light source. Testing shall also include Optical Time Domain Reflectometer (OTDR) at both 850 and 1,300 nanometers for all installed fiber strands.
 - 1. Recommended Test Equipment:
 - a. Multimode: Siecor OM-100F and OS-100D or equivalent power meter and light source.
 - b. Multimode: Siecor OTDRPlus with appropriate modules for testing.
 - 2. Tests:
 - a. Multi-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - 3. Test Criteria: Signal loss of less than 10 dB through entire fiber path, including cable, couplers and jumpers.
- C. Documentation (Fiber Optic): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Fiber Test Results: The results of the fiber testing shall be entered into the form "Fiber Attenuation Tests Results." Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - 1. Each cable installed shall undergo complete testing in accordance with TIA/EIA TSB-67 to guarantee performance to this standard.
 - 2. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 - 3. Test Criteria: Pass rate to conform to latest TIA/EIA Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
- D. Acceptance: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and the receipt of documentation.

3.06 CLEANING

- A. Clean optical fiber cabling and components of dirt and construction debris upon completion of installation.

END OF SECTION

SECTION 13421 - FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Parshall flume.
 - 2. Magnetic flow meter.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Magnetic Flow Meter:
 - a. ABB.
 - b. Siemens.
 - c. Endress Hauser.
 - d. Honeywell, Inc.
 - e. Johnson Yokogawa Corp.
 - f. Rosemount.
 - g. Sparling-Tigermag.
 - h. Toshiba.

2.02 MAGNETIC FLOW METER

- A. Magnetic flow meters shall be either flanged or flangeless type as indicated. Meters 4 inches or smaller shall be wafer style. Meters 6-inch or larger shall be of flange design.
- B. Meter body shall be Schedule 10, 304 stainless steel or Schedule 40 steel with 150-pound ANSI flange or AWWA Class D flange when ANSI is not an available option. Meters 4 inches or smaller shall be wafer or flangeless style and shall be designed for installation between 150 Class and 300 Class ANSI, DIN, or BS pipe flanges.
 - 1. Wafer or flangeless style meters 4 inches or smaller shall have a ceramic, Teflon, or Tefzel liner and Hastelloy "C" or platinum electrodes as indicated.
 - 2. Meters 6 to 12 inches shall have Teflon or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
 - 3. Meters 14 inches and larger shall have an Elastomer or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.

- C. Liner material shall be suitable for the process flow indicated on Drawings.
 - 1. Meters 4 inches or smaller shall be furnished with a Teflon or Tefzel liner. Exception: Ceramic liner shall be furnished for meters 4 inches or smaller used for lime slurry, sludge, and abrasive process flows.
 - 2. Teflon liner shall be furnished for meters 6 to 12 inches.
 - 3. Polyurethane liner shall be furnished for meters 14 inches and larger, or if not indicated otherwise on Drawings or in the Specifications.
- D. Electrodes shall be suitable for the process flow indicated on the drawings and shall be bullet nosed style made of Hastelloy "C." Exception: Platinum electrodes shall be provided for sodium hydroxide or other caustic process applications.
- E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.
- F. Meter below grade or larger than 10 inches shall be capable of withstanding continuous submergence in up to 30 feet of water without damage. Meters 10 inches or smaller shall be capable of accidental submergence in 30 feet of water for up to 48 hours. Field coil design shall be such that they shall not overheat or otherwise be damaged if flow tube is not totally filled with fluid. Magmeters shall be provided with 2 grounding rings.
- G. The sensing element shall be constructed of suitable materials to withstand submergence to 30 feet to IP 68 rating indefinitely. The tube shall be designed so that it may be buried to a depth of 15 feet where applicable. Provide evidence of ability to be buried. Directions for installation of conduit and wiring connections shall be clearly written and graphically shown for Installer's use.
- H. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable locally via an integral push-button arrangement or via a remote intelligent terminal. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.
- I. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.
- J. Magmeter shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable.
- K. Unit shall be supplied with an integral or local conduit-mounted flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display.

- L. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.
- M. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.
- N. Flow meter shall operate within Specifications on 120 volt AC plus 10 percent and 60 hertz plus 5 percent. Power consumption shall not exceed 25 VA for meters 24 inches and smaller, and 50 VA for meters 30 inches or greater.
- O. Input span shall be adjustable between 0-1 and 0-30 feet per second and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.
- P. System accuracy, including primary magnetic flow meter, shall be plus 0.5 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.
- Q. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall have the ability to be either integrally or remotely mounted as specified. If not specified, converter shall be remotely mounted. It shall be housed in a NEMA 4X case. When remotely mounted, the signal cable shall be provided with the proper length.
- R. Magmeter manufacturer shall comply with ISO9000 Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes. Provide spool-piece for meters sized 12 inches and smaller.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13423 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Sonic level transmitter.
 - 2. Cord type float switch.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cord Type Float Switch:
 - a. Anchor Scientific, Inc.
 - b. Consolidated Electric Co.
 - c. Pulsar, Inc.
 - 2. Sonic Level Transmitter:
 - a. Delta Controls Corp.
 - b. Environmental Monitoring.
 - c. Pulsar, Inc.
 - d. Milltronics.

2.02 SONIC LEVEL TRANSMITTER

- A. Sonic level device shall be microprocessor-based and include sensing head, control cabinet, and cable between head and control cabinet.
- B. Length of cable shall be sufficient for application shown.
- C. Sensor shall automatically compensate for ambient temperature changes.
- D. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine equipment supplied will work in each application.
- E. Drawings shall contain a typical installation detail and show location of sensors.
- F. Equipment supplier must ensure beam angle of sensor shall not have interference from walls, pipes, or other objects at each location. Shop Drawings shall be specific about model numbers at each location, and detail sketches showing mounting height, zero dimensions, span dimensions, and beam angle data for each location.

- G. Any device that will not function reliably to specifications in its application shall be replaced at CONTRACTOR's expense.
- H. Sonic sensor head shall be intrinsically safe for NEMA 7 areas (explosion-proof). Sensor head shall be epoxy-coated metal, encapsulated or mylar for corrosion resistance. Sensor head and reflector shall contain a thermostatically controlled heater for outdoor application for manufacturers that require sensor head heater for operation down to -20 degrees F.
- I. Sonic frequency shall be less than 45 kHz. Frequencies above this range will not be accepted.
- J. Control cabinet shall be supplied rated NEMA 4 or as shown on Drawings. Control cabinet shall contain a receiver processor, a full-hinged front door, a control cabinet thermostat-controlled heater for -20 degrees F operation, and local digital indicator configured in engineering units.
- K. Connections to controller and sonic sensor shall be with well-marked terminal blocks.
- L. Field adjustments shall be made through membrane keypads. Units requiring the use of an oscilloscope will not be accepted.
- M. Operational Data:
 1. Temperature: Sensor to operate within specifications over -20 degrees F to 150 degrees F. Controller shall operate from 32 degrees F to 120 degrees F without heater, and -20 degrees F with a heater.
 2. Pulse Rate: 1.5 pps minimum sensing rate.
 3. Operating Frequency: Less than 45 kHz.
 4. Reflection Blocking: Adjustable receiver blanking to operate only on first pulse received.
 5. Cable Length: Sensor and controller may be separated up to 500 feet.
 6. AGC: Automatic gain control to maximize signal to noise ratio.
 7. System Accuracy: Plus or minus 1.0 percent of full scale over the complete temperature range.
 8. Power Supply: 120-volt AC plus or minus 10 percent at 60 hertz with power consumption of 100 watts maximum exclusive of controller heaters.
 9. Output: 4-20 mA output linear with level into 0-700 ohms. Output shall be isolated, floating to prevent system ground loops when used with other control loops that have an established common at a remote location. Output time constant shall be adjustable through keypad from 1 to 10 seconds.

2.03 FLOAT SWITCH (CORD TYPE)

- A. Direct acting float switch shall be furnished to automatically detect liquid level change. Liquid rise of 1 inch from rest position shall operate float switch and reset will occur when liquid level drops 1 inch. Mounting shall be to a 1-inch vertical pipe for multiple float applications or to a flange for a single float application as shown. Free cable hanging floats with weights shall not be acceptable.
- B. Float switch shall consist of 316 type stainless steel housing, mounting clamp for 1-inch-diameter pipe, flexible 3-conductor cable with a synthetic rubber jacket, and mercury switch. Inside float housing will be a (normally open/closed) mercury switch potted in epoxy. Electrical load for switch contacts shall be rated 115-volt AC at 0.5 horsepower inductive load.
- C. Three-conductor cable shall be 14 AWG with 105 strands per conductor made for heavy flexing service and underwater use. A green grounding wire shall connect internally to float housing.

- D. Where mercury-free float switches are required, provide float with molded ABS housing and Form C contact switch. CONTRACTOR shall ensure ampere rating is suitable for load shown on Drawing.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13424 - PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Pressure seals.
 - 2. Diaphragm seals.
 - 3. Pressure switch.
 - 4. Pressure to current (P/I).
 - 5. Differential pressure to current (DP/I).
 - 6. Pressure to pressure (P/P).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pressure Switch:
 - a. Allen-Bradley, Bulletin 836T.
 - b. Mercoid Corp., Series D.
 - c. Square D, Class 9012.
 - d. United Electric Controls Co., Series 100 or 400.
 - 2. Pressure Seals:
 - a. Ashcroft.
 - b. OPW (Ronningen-Petter).
 - c. Red Valve.
 - 3. Diaphragm Seals:
 - a. Ashcroft.
 - b. ITT Conoflow.
 - 4. Pressure to Current:
 - a. ABB Kent-Taylor.
 - b. Bailey.
 - c. Foxboro.
 - d. Honeywell.
 - e. Rosemount.
 - f. SOR.
 - 5. Differential Pressure to Current:
 - a. ABB Kent-Taylor.
 - b. Bailey.

- c. Foxboro.
 - d. Honeywell.
 - e. Rosemount.
 - f. SOR.
6. Pressure to Pressure:
- a. ABB Kent-Taylor.
 - b. Foxboro.
 - c. Honeywell.

2.02 PRESSURE SWITCH

- A. Pressure switches shall be rated 3 amp at 120-volt AC with SPDT or DPDT contacts as shown on Drawings.
- B. Pressure switches shall have an adjustable differential.
- C. Proper ranges and NEMA 12, 4 or 7 housing requirements shall be as shown on Drawings. CONTRACTOR shall obtain the proper device for each application.
- D. If there is insufficient data on Drawings to determine range, overpressure, differential, and number of poles on switch, CONTRACTOR shall obtain information from ENGINEER.
- E. Shop Drawing shall show switch model number, range, differential, overpressure, contact data, and ENGINEER's number for each device.
- F. Single-pole switches and a relay will not be accepted as a substitute for 2-pole switches. Two single-pole switches individually set will not be accepted as a substitute for 2-pole switches.
- G. Pressure switch parameters vary greatly with manufacturers. If, in the judgment of ENGINEER, pressure switch submitted is operating at limits of range, overpressure, or differential, it will not be accepted if another manufacturer has a more appropriate device for application.

2.03 PRESSURE SEALS

- A. Pressure seals shall be of the isolation ring type.
- B. The seal construction shall consist of a body, 360-degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive sensing liquid and 2 assembly flanges. The Iso-Ring ID shall match the pipeline ID. The Iso-Ring OD shall not exceed the ID of the piping flange bolt circle. Units shall be designed to fit 125-pound, 150-pound, and 300-pound ANSI piping flanges, as shown on Drawings.
- C. When not shown, this information shall be obtained by CONTRACTOR from ENGINEER.
- D. The process liquid pressure is transmitted through the flexible cylinder wall and the captive sensing liquid to the pressure seal.
- E. The seal body shall be carbon steel unless otherwise required. Two assembly flanges are carbon steel or 316SS. Flexible elastomeric cylinder is Buna-N or natural rubber. Captive sensing liquid is 50 percent ethylene glycol and water mix or silicone (specify one).

- F. Seal weight in pounds not to exceed four times the nominal pipe size in inches.
- G. Installation: Centering gauges shall be provided to align the ID of the isolation ring with the ID of the process pipeline, holding the ring in place during installation.

2.04 DIAPHRAGM SEALS

- A. Diaphragm seals shall isolate the process measuring instruments from the process fluid. The diaphragm seal shall be of the removable type. The diaphragm seal shall be filled with liquid, compatible for the process shown to be measured on Drawings. The diaphragm seal shall be supplied with gaskets, bolts, capillary tubing, and fill fluids.

2.05 PRESSURE TO CURRENT (P/I)

- A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.
- B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.
- C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.
- E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent. Provide hand-held configurator.

2.06 DIFFERENTIAL PRESSURE (DP/I)

- A. Differential pressure to current signal converters shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. High and low process pressure shall be applied to sealing diaphragms in measuring section. These pressures shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to differential pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.
- B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.

- C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- D. Signal converter shall be supplied with a pre-piped stainless steel 3-valve manifold and pipe with wall flange for mounting. Two sediment traps shall be provided on water systems. Connectors may be either flanged or threaded as required. Materials of construction shall be appropriate to the material being measured. Signal connections shall be on conventional 2.125-inch centers.
- E. Units shall be supplied with an integral digital flow indicator calibrated 0 to 100 percent. Provide hand-held configurator.

2.07 PRESSURE TO PRESSURE (P/P)

- A. Pressure to pressure signal converter shall be of force balance type and shall convert a pressure input to a proportional 3-15 psi output signal. Pressure sensitive element shall be 316 stainless steel and shall be calibrated for range shown. Element shall convert input pressure into an output to operate transmitting mechanism. Unit shall include span and zero adjustments and compensate for atmospheric pressure changes.
- B. Zero suppression or elevation shall be provided as shown on Drawings. Overpressure capability shall be 300 percent of maximum line pressure as a minimum. If this data is not available on Drawings, CONTRACTOR shall obtain this information from ENGINEER before selecting device.
- C. Unit shall be supplied with an integral pressure gauge calibrated 3 to 15 psi.
- D. Gauge shall be a 2-inch or 2.5-inch dial with 1 psi graduations. Accuracy shall be 2 percent of midscale. Indicator shall be tagged showing design range in units being measured.
- E. Transmitter shall be in a NEMA 4 enclosure and operate from a 20 psig supply. Steady-state air consumption shall not exceed 0.25 SCFM. Accuracy shall be plus or minus 0.5 percent of span.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13430 - CONTROL PANELS AND CONSOLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Control panels and consoles.
 2. Switches, push-buttons, lights.
 3. Relays.
 4. Intrinsically safe isolator relays.
 5. Terminal blocks.
 6. Control power transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Switches, Push-Buttons, Lights:
 - a. Allen-Bradley (Type 800MR).
 - b. American Solenoid Company.
 - c. Arrow Hart (Type OB).
 - d. Electroswitch.
 - e. Microswitch (Series PW).
 2. Relays:
 - a. Potter-Brumfield (Type KUP).
 - b. Schrack North America, Inc. (Type CAD).
 - c. Square D Co. (Type KU).
 - d. Struthers-Dunn (Type A283).
 3. Intrinsically Safe Isolator Relay:
 - a. B/W Controls, Inc.
 - b. MTL, Inc.
 - c. R. Stahl, Inc.

- d. Symcom, Inc.
- e. Warrick Controls.
- 4. Solid-State Timers:
 - a. ATC (Series 306D).
 - b. Eagle Signal (Type DG100).
- 5. Terminal Blocks:
 - a. Allen-Bradley (Type 1492F1 or Type 1492CA1).
 - b. Altech (Type CTS4U-N).
 - c. Square D Co. (Class 9080, Type KCA-1).
 - d. Thomas & Betts (100 series or 200 series).
 - e. Weidmueller (SAKD2.5N or SAK2.5).
- 6. Fusible Terminal Blocks:
 - a. Allen-Bradley (Type 1492-CE6).
 - b. Altech (Type CAFL4U).
 - c. Square D Co. (Class 9080, Type KH-1).
 - d. Thomas & Betts (Series 300 or 0300).
 - e. Weidmueller (SAKS1 or ASK1).
- 7. Control Power Transformers:
 - a. Acme.
 - b. Sola.
- 8. Textured Polyurethane Enamel:
 - a. Sherwin-Williams, Polane T and/or Polane HST.
- 9. Wire Markers:
 - a. Brady.
 - b. T&B.
 - c. Westline.

2.02 CONTROL PANELS AND CONSOLES

A. Sheet Metal Construction:

1. Panels and consoles shall be fabricated from sheet steel welded and bolted into a rigid self-supporting structure a maximum of 90 inches high and a minimum of 20 inches deep. Overall length shall be coordinated with space requirements as indicated by Drawings. Changes in length from that shown on Drawings must be brought to attention of ENGINEER within 90 days of Contract Award. Cost to modify floor plan or wall opening shall be at CONTRACTOR's expense after this 90-day period. Panel face layouts shown on Drawings are intended to indicate relative position of all components. Supplier shall fix exact locations and overall dimensions to meet requirements of its equipment.
2. Panel and console bodies shall be 12 gauge minimum steel for panels up to 42 inches in width, and 10 gauge minimum steel for panels exceeding 42 inches in width. Panel subplates shall be same gauge as enclosure. Stiffening members shall be provided for strength and stiffness as required.
3. A minimum of 3 inches shall be provided between edge of panel subplate and outside walls of panel body to ensure adequate wire-way space for external wires entering panel. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Identification plates shall be laminated phenolic with white letters engraved on a black background and mounted with screws or double-back adhesive foam tape.
5. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering

symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.

6. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch-thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.
3. Panels shall have open bottoms except where structural members are required.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.
3. After fabrication, panel surfaces shall be given a phosphatizing treatment inside and out, and then finished with 2 coats of textured polyurethane enamel. Panel interior shall be painted white, ANSI No. 51. Exterior color will be selected by ENGINEER.
4. Panels shall have identical exterior finishes as selected by ENGINEER. Panel finishes on matching colored panels shall be identical. It is supplier's responsibility to achieve this result, especially for panels fabricated in different shops.

D. Electrical:

1. Internal panel wiring shall be 19 strand No. 16 AWG, 90°C MTW, Class C stranded, or THHN/THWN approved as 90°C MTW. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.
2. Control wiring associated with control circuits de-energized when main disconnect is opened shall be color-coded red. Control wiring associated with control circuits which remains "hot" when main disconnect is opened shall be color-coded yellow. DC control wiring shall be color-coded blue. Ground wires shall be color-coded green. Terminal blocks shall be numbered in numerical order. Yellow wiring leaving panel shall be brought to an isolated set of terminal blocks.
3. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal

- on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
4. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
 5. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
 6. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.
 7. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with a voltage insulation in excess of maximum voltage carried therein.
 8. Floor-standing panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
 9. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
 10. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.

E. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of

subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.

3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with red color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be push-to-test oil-tight construction with cap colors and voltages as required. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 120 VAC or 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.
- B. Latching Relays: Latching relays shall be transparent enclosed plug-in type with mechanical or magnetic latching, mechanical holding device, contacts rated 120V at 3 amps, and continuous duty coils. These relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.
- C. Signal Switching Relays: Instrument relays shall be those relays switching a 1-5 VDC or 4-20 mA signal. Instrument relays shall be transparent enclosed plug-in type with indicating LED and mechanical holding mechanism. Relay contacts shall be dry circuit type rated 250 mA maximum. Contact material shall be a gold-platinum-silver alloy.
- D. Intrinsically Safe Isolator Relay:
 1. Intrinsically safe relay shall be provided between raw sewage floats and control circuits or where shown on Drawings.
 2. Relay shall operate at 120 VAC plus 10 percent with a switch rating of 1 amp rms and maximum holding current of 20 milliamp for solid-state devices. Relay shall be rated for ambient temperatures of 32 degrees F to 120 degrees F.
 3. Output shall be N.O. or N.C. Equipment supplier is responsible for choosing proper output for float specified and circuits specified. If float and circuit are not defined, intrinsically safe relay shall be of such a polarity as to fail in a safe condition for function being performed.
 4. When intrinsically safe relay is required in panels exposed to outdoor temperatures, relays shall be rated for ambient temperatures of -40 to 120 degrees F, or thermostatically controlled heaters must be added to panel to maintain an ambient in panel of 32 to 120 degrees F.

2.05 TIMING DEVICES

- A. Synchronous and solid-state timers shall be plug-in type.

2.06 TERMINAL BLOCKS

- A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:
 - Black 120V power circuits de-energized when main disconnect is opened.
 - White 120V neutral conductors.
 - Red 120V control circuits de-energized when main disconnect is opened.
 - Yellow 120V control circuits which remain hot when main disconnect is opened.
 - Blue Terminal blocks for DC wiring.
 - Gray Terminal blocks for shields in DC wiring.
 - Green Ground terminal blocks.
- B. For terminals associated with 120V nonisolated input cards, individually fused terminal blocks shall be used for 120V power to field devices.
- C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.07 CONTROL POWER TRANSFORMERS

- A. Control power transformers shall be sized to handle in-rush currents and to accommodate continuous load of circuits plus 25 percent future load with 5 percent or less voltage drop. Transformer primary voltage shall be as indicated on Drawings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13491 - SPARE PARTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Instrumentation system spare parts.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Spare Parts List: Submit a list of recommended spare parts for the equipment provided as part of the instrumentation system.

1.03 DELIVERY

- A. Deliver spare parts to OWNER prior to final acceptance of instrumentation system and equipment.

PART 2 - PRODUCTS

2.01 SPARE PARTS

- A. Equipment spare parts as required for 1 year shall be provided and stored at Site by CONTRACTOR.
- B. Spares consumed during construction shall be replaced at no cost to OWNER until equipment is accepted as defined in Specification.
- C. Provide the following:
 - 1. One spare relay of each type used, including time-delay relays.
 - 2. One-year supply of expendable spares such as lamps, fuses, ink, ribbons, etc.
- D. Digital Systems: For digital systems, spare parts as required for a period of 1 year shall be provided and stored at Site, unless directed otherwise by OWNER.
- E. Provide the following:
 - 1. On systems employing PLCs, provide 1 spare circuit card of each type used in delivered equipment. Circuit cards shall include the following (matching units in service):
 - a. Analog input card.
 - b. Analog output card.
 - c. Discrete input card.
 - d. Discrete output card.
 - 2. One (1) spare Ethernet card and cable.
 - 3. One (1) spare Ethernet adapter card and cable.
 - 4. Provide a box of fuses for each size and type used.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 15050 - BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
1. Submittals.
 2. Record documents.
 3. Maintenance manuals.
 4. Quality assurance.
 5. Delivery storage and handling.
 6. Guarantee.
 7. Rough-ins.
 8. Mechanical installations.
 9. Cutting and patching.
- B. The Drawings are schematic and are not intended to show every detail of construction.
1. In general, piping/ductwork transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 2. CONTRACTOR shall fully coordinate mechanical work with other trades to avoid interferences.
 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. A schedule indicating the system, line size, line material, joints, fittings, valves, insulation thickness, hanger type and spacing, test pressure and shop finish for each system shown on the Drawings and/or specified herein.
 2. Complete layout drawings of all pipe sleeves, ductwork, etc., showing all sizes and controlling elevations. These drawings shall be reproducible and submitted on tracing, mylar or sepia paper.
 3. No work shall be undertaken until such drawings, specifications and schedules have been approved by ENGINEER. Approval of this data by ENGINEER shall not relieve CONTRACTOR of responsibility for the completeness, coordination, and dependable operation of the system as installed.
- B. Product Data: Submit in accordance with requirements of Section 01330, product data covering the items included under this Division of the Work.
- C. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Permits, Inspections and Licenses: CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory or political subdivision thereof, wherein the Work is done, or any other duly constituted public authority.
 - 1. Upon completion of the Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit three copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses and certifications when such fees are required.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.05 PROJECT CONDITIONS

- A. Explosion-proof Requirements: All work and equipment located in areas designated "Explosion-proof" shall conform to all requirements of Article 500 of the National Electric Code for Class 1, Division 1, Group. D installations, except when otherwise noted. All mechanical equipment located in these areas shall be built from nonsparking material per AMCA Std. 401-66 Type B.
- B. Corrosive Area Requirements: All heating, ventilating and air conditioning equipment, controls, ductwork, piping, supports and hangers shall be made of materials resistant to the chemicals or gases to which they are exposed, or be coated with the appropriate resistant coatings.
 - 1. The following is a partial list of areas which require equipment, piping, ductwork, supports, anchors etc. to be corrosion treated:
 - a. grit and screen rooms,
 - b. enclosed primary sanitary treatment structures,
 - c. chemical storage and handling areas,
 - d. filter areas,
 - e. high-humidity areas,
 - f. wet wells, and
 - g. other areas as indicated on Drawings.
 - 2. Acceptable Manufacturers: Products shall meet the requirements of this Section and be the product of:
 - a. Liberty Plastics.
 - b. Plasite (Wisconsin Protective Coating Corp.).
 - 3. Hanger, supports, anchors in corrosive areas shall be 304 or 316 stainless steel.
 - 4. In chemical feed and storage area hangers and supports shall be FRP.
- C. Painting and Identification: Painting of piping and drainage lines installed as a part of this Work will be done under Section 09900, Painting.
 - 1. CONTRACTOR under this Section shall identify and label lines clearly so painting contractor can apply correct color(s) to each pipe.
 - 2. CONTRACTOR under this Section shall apply pipe labels to the pipe after painting has been completed. The piping labels shall include the pipe material and flow direction.

- D. Motors: Motors shall comply with the specifications as set forth in Section 16220. Submit motor manufacturer's name with Shop Drawings for approval.
 - 1. All motors in Division 15 shall be TEFC Premium Efficiency unless noted otherwise in the specific Division 15 Sections or on mechanical drawing Schedules.
- E. Stainless Steel: All stainless steel referenced in the specifications is 304 or 316 Stainless Steel unless otherwise noted herein or on the drawings.

PART 2 – PRODUCTS

2.01 PIPE LABELS

- A. Provide Vinyl pipe label that attach to the pipe with tie-wraps or formed label that snaps on the pipe. Labels shall be rated for indoor and outdoor use.
 - 1. Label ManufacturesL Seton Name Plate Corporation, W.H. Brady, James H. Matthews, or approved equal.
- B. Labels that use adhesive shall not be used.
- C. Where product labels are not available for the media in the pipe, the contractor may paint the background the stencil the pipe product and flow arrow on the pipe.

PART 3 - EXECUTION

3.01 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.02 MECHANICAL INSTALLATIONS

- A. General: 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 all 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. Furnish, set, and grout or secure in place all required sleeves.
 - 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.

- B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 1. Unless noted otherwise on Drawings, mount unit heaters 8'-0" above finished floor.
- C. Coordinate 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.
- D. Install systems, materials, and equipment to conform with approved submittal data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- E. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- F. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- G. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Section 08348.
- H. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.03 PIPE AND EQUIPMENT IDENTIFICATION:

- A. Label all piping showing contents and direction of flow.
- B. Place label adjacent to each valve and branch takeoff, at each side of a wall or partition through which pipe passes; and at 20 feet 0 inch spacing on straight runs.
- C. Label Manufacturers: Seton Name Plate Corporation, W.H. Brady, Topflight Tape Company, James H. Matthews, or approved equal.
- D. Paint or stencil 1-1/2 inch high black enamel block type letters or numerals on all equipment items

3.04 VALVE IDENTIFICATION:

- A. A. Stainless Steel Tags : 1-inch diameter, secured to each valve with S-hook or stainless steel connector and stamped with system designation and assigned number.
- B. Obtain existing valve schedule from Owner and review existing valve naming sequence. Submit proposed schedule showing proposed continuation of sequence to Architect / Engineer for approval. Provide a printed schedule, in duplicate, describing each valve by number, giving location and service for which used.

3.05 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the following requirements:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
- C. Upon written instructions from ENGINEER, uncover and restore Work to provide for ENGINEER observation of concealed Work.
- D. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- E. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- G. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.
- H. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

END OF SECTION

SECTION 15060 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of supports and anchors required by this Section is indicated on Drawings and/or specified in other Division 15 Sections.
- B. Types of supports and anchors include the following:
 - 1. Horizontal piping hangers and supports.
 - 2. Vertical piping clamps.
 - 3. Hanger rod attachments.
 - 4. Building attachments.
 - 5. Saddles and shields.
 - 6. Spring hangers and supports.
 - 7. Miscellaneous materials.
 - 8. Anchors.
 - 9. Equipment supports.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 Sections.
- D. All supports, hangers and anchors shall be 304 stainless steel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's assembly type Shop Drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
 - 2. Submit manufacturer's technical product data, including installation instructions, for each type of support and anchor.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each type of support and anchor.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

- C. Manufacturers Standardization Society of the Valves and Fittings Industry, Inc. (MSS) Standard Compliance:
 - 1. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - 2. Select and apply pipe hangers and supports complying with MSS SP-69.
 - 3. Fabricate and install pipe hangers and supports complying with MSS SP-89.
 - 4. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Hangers and Supports:
 - a. B-Line Systems, Inc.
 - b. Carpenter and Patterson, Inc.
 - c. Corner & Lada Co., Inc.
 - d. Elcen Metal Products Co.
 - e. Fee & Mason Mfg. Co., Div. Figgie International.
 - f. Anvil International.
 - 2. Saddles and Shields:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.02 MATERIALS

- A. Hangers, supports, and anchors shall be 304 stainless steel.
- B. Hangers, supports, and anchors shall be 316 stainless steel or FRP construction in corrosive environments unless otherwise hereing or on the drawings.
- C. Hangers, supports, and anchors shall be standard materials except as noted herein or on Drawings.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.
 - 1. Adjustable Steel Clevis Hangers: MSS Type 1.
 - 2. Pipe Hangers: MSS Type 5.
 - 3. Adjustable Band Hangers: MSS Type 9.
 - 4. Adjustable Roller Hangers: MSS Type 43.
 - 5. Pipe Roll Stands: MSS Type 44.
 - 6. Pipe Rolls and Plates: MSS Type 45.
 - 7. Adjustable Pipe Roll Stands: MSS Type 46.

2.04 VERTICAL PIPING CLAMPS

- A. Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.
1. Two-Bolt Riser Clamps: MSS Type 8.

2.05 HANGER-ROD ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper piping systems.
1. Steel Turnbuckles: MSS Type 13.
 2. Malleable Iron Sockets: MSS Type 16.
 3. Steel Weldless Eye Nuts: MSS Type 17.

2.06 BUILDING ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.
1. Concrete Inserts: MSS Type 18. Inserts for concrete shall be galvanized steel, 304 stainless steel.
 2. Top Beam Clamps: MSS Type 25.
 3. Steel Brackets:
 - a. Side Beam Brackets: MSS Type 34.

2.07 SADDLES AND SHIELDS

- A. Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40, of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360-degree insert of high density, 100 psi, waterproof calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.08 SPRING HANGERS AND SUPPORTS

- A. Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
 - 1. Restraint Control Devices: MSS Type 47.
 - 2. Spring Cushion Hangers: MSS Type 48.

2.09 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA Standard ML 1.
- B. Steel Plates, Shapes, and Bars: Provide products complying with ANSI/ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1 part cement to 3 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- E. Pipe Guides: Provide factory-fabricated guides, of stainless steel, consisting of bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors, and associated Work, Installer shall meet at Site with CONTRACTOR, Installer of each component of associated Work, inspection and testing agency representatives (if any), Installers of other work requiring coordination with Work of this Section, and ENGINEER for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper-plated or by other recognized industry methods.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.1 Pressure Piping Codes are not exceeded.
- F. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.1.
 - 2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8-inch and over, install wood insulation saddles.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.05 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, and to prevent transfer of loading and stresses to connected equipment.

- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.1 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for pre-set of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS

- A. Furnish to CONTRACTOR, scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.07 ADJUSTING AND CLEANING

- A. Adjust hangers so as to distribute loads equally on attachments.
- B. Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 15100 - PRESSURE PROCESS PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. Provide all labor, materials, and equipment necessary for fabrication and production of the items specified in this Section and as shown on Drawings or listed on Schedule.
 2. Unless otherwise noted on Drawings, or in this Section, pressure process piping 4 inches in diameter and larger shall be part of this Work.
 3. Dismantling of existing piping and supports, where required or shown or noted on Drawings; piping connections to existing piping, structures, valves, gates, measuring devices, pumps and other equipment, including equipment erected under other Contracts, are included in Work of this Section. Piping shall contain necessary unions or companion flanges to allow ease of equipment removal.
 4. Complete all the demolition work and repair thereof to existing walls and slabs as required for the installation of this Work including grouting of all sleeves and castings. Provide all necessary joint and coupling materials, including bolts, nuts and gaskets, wall castings or sleeves, and standard or special fittings. Furnish hangers, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and special fittings. Provide and secure in proper alignment, all sleeve and casting openings in existing walls and slabs, including repair thereof.
 5. Provide all shop-applied interior and exterior pipe linings and coatings. Provide plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, painting, testing, and disinfection, as required to accomplish Work as specified and shown on Drawings.
- B. Products Installed But Not Furnished Under This Section: Install process valves, hydraulic gates, flow meters, and other appurtenances which are furnished under other Sections and incorporated in the piping systems as shown on Drawings and specified in this Section.
1. All pipe insulation shall be accomplished under Section 15080. Under this Section of Work, all shop-applied surface coating shall be furnished as herein specified and pipe testing accomplished prior to insulating.
 2. Sewers are specified under Division 2.
 3. All exposed pipe, field-applied finish painting preparation and repair of existing painted surfaces shall be done under Division 9.
 4. Floor and roof drain systems are specified under Section 15150.
- C. Products Supplied But Not Installed Under This Section:
1. All piping, fittings, appurtenances, and shop-applied coatings shall be supplied as specified under this Section.
 2. The installation and testing of Water Distribution and Pumping Mains shall be performed as specified in this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances.

They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.

2. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.
3. Design details of joints and joint restraint shall be submitted to ENGINEER for ENGINEER's consideration and approval before ordering any pipe.
4. Product Data: Submit product data covering the items included under this Section.

- B. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of Section 01770.

1.03 QUALITY ASSURANCE

- A. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.
- B. Codes, Ordinances, and Standards: Manufacture, storage, and erection of equipment under this Contract shall be in accordance with current ASA (ANSI), AWWA, and ASTM Standards. Standards and Specifications referenced herein shall be the current published edition. The manufacturer of the pipe and fittings shall furnish ENGINEER a certified statement that all pipe and fittings furnished by manufacturer meet the material requirements and have been inspected and tested in accordance with the applicable Specification and Standard.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Disinfection compounds shall be stored in well-ventilated areas protected from moisture and fire.
- B. Storage:
1. All pipe and related items installed under this Section shall be stored as recommended by manufacturer.
 2. CONTRACTOR shall take all actions necessary to protect all items installed under this Contract including furnishing all special storage areas required by equipment manufacturers.
 3. Pipe shall be stored on suitable timber skids free from contact with the ground. Gaskets shall be stored in as cool, clean, and shaded a place as practical.
- C. Handling:
1. All items installed under this Contract shall at all times be handled as recommended by manufacturer and in such a manner as to avoid any damage.
 2. All special handling equipment and temporary supports shall be provided by CONTRACTOR.
 3. Items will be subject to inspection and approval upon delivery to the Site and after storage. No cracked, broken, or damaged pipe shall be used.
 4. In the event coatings are damaged, the damaged area shall be recoated with an approved coating similar to that specified for that item.
 5. Steel pipe shall be handled by means of rubber or fabric slings. No hooks shall be permitted to come in contact with joint rings or be inserted in the ends of the pipe and fittings for any reason.
 6. During handling, hauling, and storage of pipe, each piece shall be kept from contact with adjacent pieces by means of wooden blocks or timbers.

1.05 PROJECT CONDITIONS

- A. Existing Conditions: The Drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, CONTRACTOR shall so inform ENGINEER for ENGINEER's approval.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Adapter Flange Coupling (AFC):
 - a. EBAA Iron Sales, Inc. (Series 2100 Megaflange).
 - b. Smith-Blair, Inc.
 - c. Uni-Flange Corp.
 - d. Victaulic Co.
 2. Bolted Flexible Coupling (BFC):
 - a. Dresser Industries, Inc.
 - b. Smith-Blair, Inc.
 3. Grooved Couplings (GC):
 - a. Victaulic.
 - b. Grinnell.
 - c. Anvil.
 4. Push-On Joints (POJ):
 - a. Bell-Tite.
 - b. Ring-Tite.
 - c. Tyton.
 - d. Fastite.
 5. Plastic Pipe (PVC):
 - a. Spears.
 - b. Harvel.
 - c. JM Eagle.
 6. Equipment Connections:
 - a. Garlock.
 - b. Metra Flex.
 - c. Mercer Rubber Co.
 - d. Redflex.
 - e. Atlantic Metal Hose Co. (Vibra-flexor).
 - f. Allied Metal Hose Company.
 - g. Universal Oil Products Flexonics Division.
 7. Hangers and Supports:
 - a. Grinnell.
 - b. Elcen.
 8. Utility Markers:
 - a. ScotchMark mid-range markers, Model 1258, as manufactured by 3M Company.
 - b. 3M Marker Locator Model 1265.
 9. Mechanical Joint-Retaining Glands, no substitution or "or equals" will be accepted:
 - a. "Megalug Series," as manufactured by EBAA Iron.
 - b. "Blockbuster 1400 Series," as manufactured by Uni-Flange (Ford Meter Box Co.).

- 10. Mechanical Sleeve Seals:
 - a. Thunderline Corp.
 - b. Calpico, Inc.

2.02 MATERIALS

A. Disinfection Products:

- 1. Liquid Chlorine shall not be allowed for this Project.
- 2. Sodium Hypochlorite shall meet the requirements of AWWA B300. Containers shall have an expiration date marked at time of shipment to ensure that excessive deterioration has not occurred.
- 3. Calcium Hypochlorite shall meet the requirements of AWWA B300.

2.03 PIPE JOINTS

A. All joint material and lubricants shall be furnished with the pipe, including all joint material required for connection to equipment furnished under other Sections. All joint materials shall be assembled in accordance with standard practice and manufacturer's recommendations. All equipment connections shall be flanged, union, or grooved coupling so that equipment can be removed without disassembly of the connecting piping.

B. Bolted Flexible Couplings (BFC): Bolted flexible couplings shall consist of a steel sleeve, with centering bead removed, rubber gaskets, follower rings, and a full complement of nuts and bolts. Couplings shall allow a deflection of approximately 4 degrees per joint.

- 1. Couplings shall have a minimum middle ring thickness and minimum length as follows:

<u>Pipe Size (inches)</u>	<u>Middle Ring Thickness</u>	<u>Middle Ring Length</u>
4	0.203-inch	5-inch
6 to 12	1/4-inch	5-inch
14 to 20	5/16-inch	7-inch
24	3/8-inch	7-inch
30 to 48	3/8-inch	10-inch
54 to 72	1/2-inch	10-inch

- 2. Couplings shall have a maximum gap between pipe ends as follows:

<u>Sleeve Length</u>	<u>Max. Gap Allowed</u>
5-inch	1-inch
7-inch	2-inch
10-inch	3-inch

- 3. Couplings and accessories shall be galvanized and shall be shop coated with a sealer suitable for subsequent field painting or coating.

C. Rubber Expansion Joints: Shall be used in the aeration piping to allow for expansion and contraction of the piping.

1. Expansion joints shall be arch type and constructed of multiple plies of woven, polyester fabric, impregnated with Buna N or chlorobutyl rubber elastomer and reinforced with welded steel rings imbedded in the body.
 2. They shall have ANSI 125-pound flanges and be hypalon coated. Each end flange shall be backed up with 3/8-inch-thick galvanized steel retaining ring. Control rods shall be provided on the expansion joint to restrain the piping in the axial direction.
- D. Flanged Joints (FJ): Pipe flanges shall conform to American Standards: dimensions, ANSI B16.1 and threads, ANSI B2.1. Flange faces except stainless steel shall be coated with a rust inhibitor immediately after drilling.
1. Flanges for cast or ductile iron pipe and fittings shall be ductile iron and meet the requirements of AWWA C115 (ANSI 21.15).
 2. Flanges for steel plate pipe and fittings shall meet the requirements of AWWA C207 Standard Steel Ring Flanges, Class B, except high service discharge piping as noted on Drawings or on Schedule, shall be Class D.
 3. Flanges for stainless steel pipe shall be fabricated from stainless steel flat plate of the same composition as the pipe.
 4. Flanges for stainless steel tubing shall be constructed using standard steel angle face rings (Van Stone Connection) and galvanized carbon steel backup flanges.
 5. Flanged joints shall be made up with full-face 1/8-inch rubber gaskets. Gaskets for gas lines shall be neoprene.
 6. Flanges shall be firmly bolted with machine, stud or tap bolts of the proper size and number meeting the requirements of ASTM A 307, Grade B. Joints made with bolts or bolt studs shall have a nut on each side. Bolt projection through nuts shall be equal, and where studs are used, bolt projection on each side of the flange shall be equal.
 7. All nuts and bolts shall be zinc plated or hot-dip galvanized except on stainless steel flanges shall be 316L stainless steel.
 8. Flange connections to all flexible connectors and expansion joints shall have a lock washer under all nut and bolt heads, 2 control rods across each joint and steel retainer rings at each flange. All steel materials shall be galvanized.
 9. Flange joints shall not be used on ground-buried pipe.
- E. Grooved Couplings (GC): Provide rigid grooved couplings where shown or noted on Drawings or noted on Pipe Schedule. Flexible type shall only be used in applications approved by ENGINEER.
1. Grooved couplings and fittings may be used in lieu of flanged joints.
 2. Couplings shall conform to AWWA Standard C606.
 3. Gaskets shall be molded or extruded of an elastomer that is recommended by coupling manufacturer and that will satisfy the end use. End use includes consideration for pipe material and material being transmitted by the pipe.
 4. Generally, ductile iron pipe gaskets shall be halogenated Butyl compound, and steel pipe shall be an ethylene, propylene, diene-monomer (EPDM) compound.
 5. Shop Drawings submitted shall identify the gasket material, pipe material, and material being transmitted in the pipe.
 6. Cast iron or ductile iron fittings shall conform to the requirements of ANSI Specifications A21.10 or AWWA C110 with end preparation of a radius cut groove configuration.
 7. Standard weight steel pipe or better may be cut grooved in accordance with manufacturer's standard groove dimensions. Where pipe is less than or standard weight, a ring shall be welded to steel pipe to form the necessary shoulder for the joint, or the pipe may be roll-grooved in accordance with manufacturer's recommendation for roll-grooving pipe as approved by ENGINEER.

8. Ductile iron pipe in sizes 4-inch to 24-inch shall be radius cut grooved in accordance with manufacturer's specifications.
- F. Push-On Joint (POJ): Where shown or noted on Drawings rubber gasket type push-on or slip-on joints shall be allowed as approved by ENGINEER.
1. Joints shall conform to ANSI A21.11 and AWWA C111.
 2. Push-on joints shall generally be used on all ground-buried ductile iron or PVC pipe.
 3. All push-on joints are to be restrained in accordance with the paragraph on joint restraints.
- G. Mechanical Joints (MJ): Mechanical joint shall conform to ANSI A21.10 and AWWA C110, or ANSI A21.11.
1. Each joint shall be complete with rubber gasket, cast iron gland and a full complement of high-strength, low-alloy steel bolts and nuts.
 2. All mechanical joints are to be restrained in accordance with the paragraph on joint restraints.
- H. Socket Type Joint (STJ): Plastic pipe joints shall be solvent cemented socket-type meeting the requirements of ASTM D 1785 and D 2467, Schedule 80, and fiberglass-reinforced pipe joints shall be adhesive bell and spigot type as approved by ENGINEER.
- I. Welded Joint (WJ): Butt-welded joints shall be used whenever shown or noted on Drawings. Welding shall comply with the current AWWA Standard C206. Lap-welded joints may be used if approved by ENGINEER.
- J. Adapter Flange Coupling (AFC): Adapter flange couplings for steel or ductile iron pipe shall be provided where shown on Drawings.
1. The coupling shall be designed to meet the test requirements of ANSI B16.1, 125-pound flanges.
 2. The coupling shall be designed to handle a 525 psi hydrostatic test and 175 psi working pressure at temperatures of -20 to 150 degrees Fahrenheit without leaking or requiring additional restraint.
 3. The coupling shall consist of a standard flange drilling (ANSI B16.1); a standard mechanical joint material (ANSI A21.11 or AWWA C111); and standard retainer gland construction (AISI 4140 steel setscrews, galvanized with ductile iron body ASTM A 536).

2.04 PIPING

- A. Ductile Iron Pipe (DIP): Buried ductile iron pipe shall be either the Pressure Class indicated on Bid Form or on Schedule. If no classification is indicated, pipe shall be the highest Standard Pressure Class available. Ductile iron pipe shall be manufactured in accordance with AWWA C151 (ANSI A21.51). Pipe placed in buildings to be joined by flanges or grooved couplings for the pipe size shown shall have a minimum thickness of Special Thickness Class 53. Each pipe run shall be of the same class. Pipe sizes indicated are inside diameter (I.D.).
1. Fittings for flanged ductile iron pipe shall be ductile iron or cast iron and shall meet the requirements of AWWA C110 (ANSI A21.10). Fittings for mechanical joint ductile iron pipe shall meet the requirements AWWA C110 (ANSI A21.53) Ductile iron fittings shall be rated for 350 psi, pipe sizes 24-inch diameter and less and 250 psi for pipe sizes over 24-inch diameter, except that ductile iron flanged fittings shall be rated for 250 psi for all pipe diameters.
 2. Cast iron fittings shall be rated for 250 psi, pipe sizes 12-inch diameter and less and 150 psi for pipe sizes over 12-inch diameter.

3. Ductile iron joints shall be mechanical, bolted flexible coupling, and push-on, as specified under Pipe Joints, as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER. Joints shall meet the requirements of AWWA C111 (ANSI A21.11). All joint materials shall be furnished with the pipe.
 4. Coatings and Linings: Ductile iron pipe and fittings to be ground buried shall be coated by manufacturer on the outside with an asphaltic coating 1 mil thick, in accordance with AWWA C151 and C110 (ANSI A21.51) and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4. The pipe shall be supplied with and wrapped in polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) and shall be installed following Method "A."
 5. Exposed pipe and fittings shall be coated by manufacturer on the outside with a universal rust-inhibitive primer 2 mils minimum dry thickness, and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4.
- B. Plastic Pipe (PVC): Plastic pipe shall be designed, fabricated, and installed in accordance with these Specifications and as shown or noted on Drawings and listed on Schedule.
1. Plastic pipe shall meet the requirements of ASTM D 1785 (PVC) Schedule 80, socket end ASTM D 2467.
 2. Pipe sizes indicated are I.D.
 3. Plastic pipe fittings shall meet the same requirements as the pipe and connections shall be socket type ASTM D 2467.
 4. All plastic pipe joints shall be socket type in accordance with the paragraph on "Socket Type Joints."
 5. Installation shall be in accordance with the paragraph on "Pipe Installation." In addition, the recommendations of ASTM Committee D 20 on Plastics relating to the installation of flexible thermoplastic sewer pipe shall be followed. Hanger spacing shall be as shown or noted on Drawings and meet manufacturer's recommendations as approved by ENGINEER.
- C. Polyvinyl Chloride Pressure Pipe (PVCP):
1. PVCP pipe shall be manufactured of PVC resin compounds Class 12454 A or B conforming to ASTM D 1784 in accordance with ASTM D 2241. Unless otherwise indicated on Schedule or Bid Form, all PVCP pipe shall have a pressure rating of 200 psi (SDR 21).
 2. If used for potable water service, PVCP shall meet the requirements of AWWA C900 & 905, ANSI/NSF 14 and ANSI/NSF 61.
 3. Fittings shall be cast or ductile iron of comparable class, provided with special gaskets for SDR size pipe.
 4. Joints shall be bell and spigot type with a flexible elastomeric gasket conforming to ASTM D 3139. Joints shall be made using lubricant as supplied and as directed by manufacturer. If it is necessary to field cut a standard length of pipe, the new spigot end shall be prepared as recommended by pipe manufacturer.
 5. After delivery, PVCP pipe shall be stored on a flat surface so that the barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet. If the pipe is to be stored for an extended period of time, it shall be covered with an opaque material so it is protected from the sun's rays and the bells shall be inverted in alternate rows so they are not supporting the direct load of the pipe. Deflection of any particular amount of PVCP pipe shall not exceed 5 percent.

2.05 WALL AND SLAB SLEEVES AND CASTING

- A. At all points where pipes must pass through the walls, floors, or slabs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings. Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be sealed at the inside and outside wall faces on walls

exposed to earth or water/sewage, at one face of other walls, and at the top surface of floors and slabs with a rubber link seal.

- B. In general, the wall sleeve or castings shall be of the same material as the pipe. Iron pipe wall castings, wall pipe, transition sleeves, and solid sleeves shall meet the requirements of AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B.
- C. Steel sleeves and wall pipe shall not be painted in areas to be embedded in the concrete. Under this Section, all loose rust, scale, grease, or oil shall be removed prior to pouring of the concrete.
- D. Where watertightness is essential and at other locations where indicated on Drawings, wall castings, and sleeves shall be provided with an intermediate flange located approximately at the center of the wall.
- E. Sleeves and castings at the point of manufacture shall be coated on the inside with a universal rust-inhibitive primer 1.5 to 2.0 mils minimum dry thickness.
- F. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

2.06 EQUIPMENT CONNECTIONS

- A. The connecting piping to pumps and other equipment shall be supported independently of the pump or equipment so as to avoid any strain on the pump or equipment.
- B. All equipment connections shall be flanged or have unions to facilitate removal of the equipment.
- C. Piping to vibrating equipment shall contain control-rodded, retainer ringed flanges, flexible spool-type expansion joint of duct and chlorobutyl or Buna-N material as shown or noted on Drawings.
- D. All carbon steel shall be galvanized.

2.07 JOINT RESTRAINT

- A. Where water or air pressure exerts a disjoining force, at all pipe deflections over 20 degrees, and all tees and dead ends, joints shall be restrained, tied, or harnessed in a manner approved by ENGINEER.
- B. The restraint shall be applied to joints in each direction from the deflection an adequate distance to resist the axial thrust of the test pressure as shown on Pipe Restraint Schedule on Drawings. Fire hydrants shall be restrained from the main line to the hydrant. Details of all proposed joint restraint, showing the type and locations, shall be submitted to ENGINEER for approval. Concrete thrust blocks will not be permitted except where noted. All pipe and fitting restrained joints shall be rated for a minimum of 250 psi.
- C. For unit price items, joint restraint shall be considered as included in the prices Bid for the type and size of pipe listed on Bid Form.

- D. Acceptable methods of joint restraint are as follows:
1. Ductile Iron Pipe: Mechanical joint pipe with EBAA Iron "Megalug Series," or approved equal. Megalugs or approved equal may also be used to restrain joints for unanticipated deflection points, or where connections require a mechanical joint. Restrained joint glands and hardware shall have surfaces factory prepared and protected with a corrosion resistant coating system. Glands shall have a polyester or epoxy fusion bonded coating. Wedges, nuts and bolts shall have two coats of a heat cured blue fluoropolymer coating or alternatively made of stainless steel. No other manufacturers or types of mechanical joint-retaining glands will be accepted. Push-on joint pipe shall be restrained with American Flex-ring Gaskets, U.S. Pipe TR Flex, or approved equal.
 2. Polyethylene Pipe: None required, except concrete thrust block around thrust or anchor ring required at connections to unrestrained pipe.

2.08 JOINT HARNESSING

- A. Pipe and fittings that require harnessing shall be provided with standard lugs ASTM A 283, Grade B, or A 285, Grade C, or equal, meeting the requirements of AWWA Specification C111 or AWWA Manual M11, unless otherwise noted.
- B. Harness tie rods and nuts shall be mild steel meeting the requirements of ASTM A 193, Grade B7, or A 307, Grade B, or equal with American Standard threads. The nuts shall seat on steel plate washers. The rod, washers, and nuts shall be hot-dip galvanized ASTM A 153.

2.09 HANGERS AND SUPPORTS

- A. Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for piping, apparatus, and equipment installed under this Section. All supports and parts shall conform to the latest requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Specification or as detailed on Drawings. Materials shall be stainless steel.
- B. Hangers and supports shall be adequate to maintain the pipelines, apparatus, and equipment in proper position and alignment under all operating conditions with due allowance for expansion and contraction, and shall have springs where necessary. Hangers and supports shall be of standard design where possible and be best suited for the service required, as approved by ENGINEER. Supporting devices shall be designed in accordance with the best practice and shall not be unnecessarily heavy. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 5 for each hanger. Hangers shall have a minimum spacing in accordance with ANSI B31.1. Point loading hangers are not acceptable. Hangers shall be sling or saddle type.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamp, and structural attachments shall be beam clamps. All rigid hangers shall provide a means of vertical adjustment after erection. Generally, hangers shall be sized for supporting the pipe, excluding insulation. Proper pipe protection saddles shall be installed on pipes that are covered with insulation where hangers and supports are outside the insulation. Overhead hangers shall be supported by threaded rods properly fastened in place by suitable screws, clamps, inserts or bolts, or by welding. Saddle stands shall be of the adjustable type. Each stand shall consist of a length of steel pipe fitted at the base with a standard threaded flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to the floor, foundation, or concrete base.

- D. Anchors shall be furnished and installed where specified, shown, or required for holding the pipelines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to approval by ENGINEER. Materials shall be galvanized or stainless steel. Inserts for concrete shall be galvanized or stainless steel or galvanized malleable iron and shall be installed in the concrete structures where required for fastening supporting devices. They shall be designed to permit the rods to be adjusted horizontally in one place and to lock the rod nut or head automatically. Inserts shall be recessed near the upper flange to receive reinforcing rods. Inserts shall be so designed that they may be held in position during concrete pouring operations. Inserts shall be designed to carry safely the maximum load that can be imposed by the rod that they engage.
- E. Casing spacers shall be timber strapped to the carrier pipe or stainless steel with high-density plastic runners. Timber spacers shall be treated lumber to resist decay or insect damage and shall be strapped to the carrier pipe as indicated on Drawings. Stainless steel casing spacers shall be Cascade Waterworks Manufacturing Company (Yorkville, IL) or equal. Spacers shall be installed per manufacturer's recommendation. Filling of the annular space shall be as specified in Section 02445.
- F. Pipe supports on aeration pipe shall allow for expansion and contraction of pipe. Unless otherwise noted on drawings the aeration pipe supports shall be of slide type, Anvil International Type 3 and 6 or equal. Materials shall be stainless steel or galvanized. See drawings for pipe supports from bridge.
- G. Concrete supports shall be placed wherever shown or required under Division 3. Equipment shall be supported in accordance with manufacturer's recommendations.

2.10 CLEANOUTS

- A. Cleanouts shall be provided where shown or specified. Cleanout openings for pipe 8 inches or larger in diameter shall be not less than 6 inches in diameter (unless otherwise noted on Drawings).
- B. Cleanout openings for pipe 6 inches and smaller shall be of the same diameter as the pipe.
- C. Cleanout covers shall be standard 125-pound blind flanges, where conformation is required with the inside curvature of the pipeline, in which case the covers shall be flanged of proper shape with standard flange drilling.
- D. Covers shall be fastened by means of galvanized steel studs and nuts and shall be drilled and tapped for a 1-1/2-inch pipe connection. A 1-1/2-inch galvanized steel plug shall be furnished. The flange or conformed plugs shall be provided with a dowel or other suitable means to ensure proper setting.

2.11 TAPS AND PLUGS

- A. Where indicated or required, pipe or fittings shall be tapped to receive small or special fittings under this or other headings of the Work. Required taps shall be provided as part of this Work.
- B. All taps shall be temporarily plugged at point of fabrication.

2.12 SOURCE QUALITY CONTROL

A. Tests, Inspections:

1. All pipe and fittings delivered to the Project shall be accompanied by certification papers showing that the pipe and fittings have been tested in accordance with the applicable Specifications and that pipe and fittings meet the Specifications for this Project. All pipe and fittings will be inspected upon delivery to the Site by ENGINEER or OWNER's Representative. No cracked, broken, or damaged pipe or fittings will be allowed in this Work.
2. Ductile Iron Pipe:
 - a. Each pipe shall be hydrostatically tested to 500 psi at the point of manufacture.
 - b. The class of nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, county where cast, year in which the pipe was produced, and the letters "DI" or "ductile" shall be cast or stamped on the pipe.
 - c. Where required, other designation marks shall be painted on the pipe or fittings to indicate correct location in the pipeline in conformity to a detailed layout plan.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail Drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer approved by ENGINEER.

3.02 INSTALLATION

- A. Laying and Erecting Pipe: Pipe shall be installed as recommended by manufacturers or by the applicable AWWA installation manual or specification.
1. Pipe shall be carefully laid to line and grade as shown on Drawings. Care shall be taken to keep the interior of the pipe clean and free from dirt and other foreign materials.
 2. Bulkheads or other means shall be used at the open ends of the pipe for this purpose. At the end of each day's work, ground-buried pipe shall have its working end bulkheaded.
 3. Ground-buried ductile iron pipe shall be wrapped with polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) following Method "A."
- B. Carrier Pipe Installation: Attach casing pipe spacers and insert carrier pipe into casing at the depth and grade indicated. Filling of annular space and closure of the ends shall be in accordance with Section 02445.
- C. Field Cutting Piping: The spigot ends of all pipe lengths, which have been cut in the field, shall be ground to a smooth surface and painted with 2 coats of asphaltum metal protective paint.
- D. Bolted Flexible Couplings (BFC): All bolted flexible couplings shall be harnessed with tie bolts or studs across the joint, design based on test pressures.
1. On cast iron or ductile iron pipe, tie bolts shall be installed between flanges across the coupling unless otherwise noted on Drawings or approved by ENGINEER.
 2. Piping of other materials shall be furnished with lugs. The number and size of the bolts and studs and other details of the harnessed joint shall be submitted to ENGINEER for review.
 3. Tie bolts or studs shall be galvanized.

- E. Concrete Encasement: Where shown on Drawings or directed by ENGINEER, pipework shall be encased in concrete.
 - 1. In general, pipe will be encased when it passes under structures.
 - 2. Pipe to be encased shall be supported on wood blocking at least at two points for each length of pipe and joints made and the line tested wherever specified. Blocking shall be of sufficient size to raise the pipe at least 6 inches above the bottom of the trench so that a 6-inch encasement may be placed entirely around it.
 - 3. After an approved test of the pipeline, concrete encasement shall be placed.
- F. Concrete Cradle: Pipework shall be placed on Class "C" concrete cradle in locations and according to details shown on Drawings.
- G. Bedding: Where the subgrade is disturbed during excavation, the space shall be refilled with bedding material solidly tamped to form a firm foundation for the pipe.
 - 1. At least the bottom quarter of the pipe shall be laid on a sand or pea gravel bedding, except that the bedding shall be exclusively pea gravel for pipe 48 inches and larger in diameter. Bedding shall be provided as specified under Division 2.
- H. Joints: All joints shall be assembled in accordance with that described in the "Pipe Joints" Article.
- I. Connections to Existing Facilities:
 - 1. CONTRACTOR shall furnish all labor and materials required for the connection of piping under this Contract to existing structures as called for on Drawings.
 - 2. Where breaking holes for connections to existing structures, care shall be taken to prevent debris from entering.
 - 3. After installation of the pipe, the structure shall be pointed up around the pipe, both on the inside and outside so that it is restored to a watertight condition.
- J. Connections to Existing Mains: Where shown on Drawings, connections of existing main to the new mains shall be done only after the new mains are shown to be disinfected by the results of the bacteriological analysis. Care should be taken to prevent debris from entering water main.

3.03 PIPE LOCATING SYSTEMS

- A. Utility Markers: All plastic pipe pumping mains shall have an electronic marker system furnished and installed complete with marker locator.
 - 1. Markers shall be installed in a horizontal position 3 to 4 feet below the ground surface.
 - 2. A marker shall be placed over every buried tee, bend, or saddle fitting, at intervals no greater than 100 feet along pumping mains and where directed by ENGINEER.
 - 3. Holes shall be excavated over bored or directionally drilled pumping main for placement of markers.
- B. Wire Pipe Location System: All directional bores shall be marked with copper tracer wire.
 - 1. Copper wire shall be 6 AWG type RHW and be strung continuously along the pumping main.
 - 2. The wire shall be fastened to all gate valves or manholes which may serve as access points.
 - 3. Directional bores of less than 100 feet and bores in residential areas that will have service lateral taps on the pipe shall be marked with utility markers.
 - 4. CONTRACTOR shall test the locator system, before payment, for pumping main that is directionally bored.

5. Failure of the copper wire shall result in the installation of utility markers at no additional cost to OWNER.

3.04 REPAIR

- A. Repair of all damaged interior pipe coatings, ground-buried exterior pipe coatings and galvanized coatings shall be under this Section. Repair of exposed painted pipe shall be as specified under Section 09961.
- B. For field-welded joints, both inside and outside, coatings shall be left off for a distance of 6 inches from each end. These areas shall be shop primed. After completing the welded joint and under this Section, the interior of all joints and exterior of ground-buried pipe shall be thoroughly cleaned, primed, and given field coating of the same material as specified for the pipe. Coating shall meet the requirements of AWWA C203 or AWWA C210, as approved by ENGINEER. Exposed field-welded joints shall be cleaned under this Section to remove slag and scale, and then shall be finish cleaned, primed and painted under Division 9.
- C. Damaged linings, coatings, and wrapping shall be repaired under this Section and, if possible, before pipe is laid.
 1. Surfaces shall be thoroughly cleaned, dried, and free of old materials.
 2. They shall then be given a field coating of the same material as specified for the pipe.
 3. Coating shall meet the requirements of AWWA C203, AWWA C210, or AWWA C602 as approved by ENGINEER.
 4. All other pipe coatings and linings shall be as stated in "Piping" Article.

3.05 FIELD QUALITY CONTROL

- A. Defective Pipe: No pipe or special casting known to be defective shall be laid in Work.
 1. Any piece found to be defective after it has been laid shall be removed by CONTRACTOR and replaced by a sound and perfect piece.
 2. If the major part of a defective pipe is sound, the good end may be cut off and used.
 3. The cutting of pipes for this and any other purpose shall be done by skilled workers, and in such manner as will not injure the pipe. Every such cut shall be square and smooth. Cut surfaces shall be recoated as specified for the pipe.
- B. Tests:
 1. After completion, each run of pipe shall be tested by CONTRACTOR in the presence of ENGINEER. All appurtenances such as service connections, corporation stops, and curb stops shall be tested with the run of pipe.
 - a. Any leaks shall be made tight.
 - b. Under this Work, CONTRACTOR shall furnish all water or air, piping, bulkheads, pumps or compressors, gauge, and other equipment required for the test.
 - c. The section of pipe to be tested shall be cleaned and isolated by valves or plugs, and shall not exceed 2,000 feet for any individual test. Such valves or plugs shall be designed to hold against the test pressure. Sections of pipe shall have an opening through which air or water can be introduced. The supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the pressure. The pressure gauge shall have a minimum diameter of 3-1/2 inches and a range compatible with the test pressure. Pipelines that cannot be closed for a direct pressure test shall be tested by filling the tanks to which they are connected to the highest operating level or installing temporary test bulkheads. After completion of tests, all pipes shall be drained. Buried pipelines shall be pressure

tested with all pipe joints exposed for visual inspection unless otherwise directed by ENGINEER.

- d. If requested by ENGINEER, CONTRACTOR shall furnish proposed test procedures for approval including pipe identification, test pressure and a description of the method of testing.
 - e. In the event that the leakage exceeds the specified amount, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or special castings found to be cracked shall be removed and replaced with new pieces by CONTRACTOR. After this Work has been done, the test shall be repeated. Final acceptance of the lines will not be made until satisfactory tests have been passed.
2. Test Pressures: In general, pipelines shall be tested at 1-1/2 times their working pressure or at the test pressure indicated on Piping Schedule. Adjustments for hydrotest water temperature and water column elevation differences at point of test must be made.
 3. Hydrostatic Testing (except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.
 - a. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.
 - b. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148,000}$$

where L = allowable leakage per hour (gallons)
S = length of pipe in test (feet)
D = nominal diameter of pipe (inches)
P = average test pressure (psi, gauge)

- c. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
 - d. The test pressure shall not vary by more than 5 psi throughout the entire test period.
4. Hydrostatic Testing of HDPE Pipe: The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes. To compensate for expansion after initial pressurization, sufficient make-up water shall be added into the pipe system at hourly intervals for 3 hours to raise the pressure back up to the test pressure.
 - a. After completion of this initial phase, approximately 4 hours after start of the testing procedure, the actual test shall begin.
 - b. The system shall be pressurized up to the test pressure and by make-up water held continuously at the test pressure for at least 1 hour, but no more than 3 hours.
 - c. The make-up water used during the test shall be measured and shall not exceed the allowance given in the following table.

ALLOWANCE FOR EXPANSION OF HDPE PIPE UNDER TEST PRESSURE

Allowance for Expansion
(U.S. Gallons per 100 Feet of Pipe)

Nominal Pipe Size (In.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	11.1	16.8
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0
54	22.0	35.0	55.0

- d. If there are no visible leaks or pressure drops greater than 5 psi during the actual test period, the system passes the test. If leakage is revealed, however, the defect shall be corrected and a retest shall be made after a 24-hour minimum depressurized recuperation period.
- 5. Pneumatic Testing: The section of pipe to be tested shall be filled with air and pumped up to test pressure.
 - a. Sufficient time shall be allowed for the air pressures to stabilize at the test pressure. After the stabilization period, the air control valve shall be closed and the test period started. The section of pipe shall be maintained under the test pressure for a continuous 4-hour period with no more than a 10 percent loss in pressure over the entire test period.
 - b. Pneumatic testing of HDPE pipe shall not be allowed.
- 6. Each valve assembly shall be tested by CONTRACTOR; the test shall consist of opening and closing the valve.
- 7. Each hydrant assembly shall be tested by CONTRACTOR; the test shall consist of flushing the hydrant for a minimum of ten minutes. During the test period the 6-inch gate valve shall be closed and opened. CONTRACTOR shall furnish necessary hoses for the disposal of OWNER-furnished water.

3.06 DISINFECTION

- A. Potable water piping and water mains shall be flushed and disinfected in accordance with AWWA C 651, continuous feed or slug method. All potable water piping shall be flushed. Disinfection may precede or follow pressure testing; however, new Work shall not be connected to existing piping or water mains until two consecutive samples taken 24 hours apart have passed bacteriological tests.
- B. Provide all temporary piping, fitting, backflow preventers, disinfectant feeding equipment, sampling, and laboratory testing necessary to complete the flushing and disinfection procedure. ENGINEER shall be notified of flushing and disinfection schedules, and shall witness the sampling.
- C. CONTRACTOR shall dispose of the high residual chlorine water by a method approved by ENGINEER.

END OF SECTION

SECTION 15110 - PROCESS VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section and as shown on Drawings or on Valve Schedule on Drawings.
- B. Items furnished under this Section shall be erected under Division 15. Hanger rods, inserts and supports, flange bolts, and gaskets for valves shall be furnished and installed under Section 15100.

1.02 REFERENCES

- A. ANSI:
 - 1. B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250, and 800.
 - 2. B16.3, B2.1 Threaded Valve Joint Standards.
 - 3. B16-104 Reinforced Teflon Steel Standard.
- B. ANSI/AWWA:
 - 1. C110/A21.10 Ductile Iron and Gray Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
 - 2. C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 3. C500 Gate Valves for Water and Sewage Systems.
 - 4. C507 Ball Valves.
 - 5. C504 Rubber Seated Butterfly Valves.
 - 6. C509 Resilient Seated Gate Valves for Water Supply Service.
- C. ASTM:
 - 1. A 48 Specification for Gray Iron Castings.
 - 2. A 126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 3. A 182/A 183M Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
 - 4. A 183 Specification for Carbon Steel Track Bolts and Nuts.
 - 5. A 194/194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
 - 6. A 276 Specification for Stainless and Heat Resisting Steel Bars and Shapes.
 - 7. A 436 Specification for Austenitic Gray Iron Castings.
 - 8. A 536 Specification for Ductile Iron Castings.
 - 9. B 148 Specification for Aluminum Bronze Castings.
 - 10. B 584 Specification for Copper Alloy Sand Castings for General Applications.
 - 11. B 61 Specification for Steam of Bronze Castings.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Each valve, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Valve Schedule.

- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- C. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. All Work under this Section shall be performed in accordance with standard practices as recommended by manufacturer and AWWA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Resilient Seated Gate Valves (RA):
 - a. American Flow Control Valves.
 - b. Clow Valve Co.
 - c. M&H Valve Co.
 - d. Mueller Co. (A-2360 Resilient Wedge).
 - e. U.S. Pipe (Metroseal 250).
 - 2. Standard Swing Check Valves (C):
 - a. Clow Valve Co.
 - b. G.A. Valves (Golden Anderson).
 - c. Kennedy Valve.
 - d. M&H Valve Co.
 - e. Rensselaer Valve Mfg. Co.
 - 3. Combination Air and Vacuum Release Valves (ARV):
 - a. APCO Valve & Primer Corp.
 - b. Crispin.
 - c. G.A. Valves (Golden Anderson).
 - d. Val-Matic Valve & Mfg. Corp.
 - 4. Plug Valves (P):
 - a. Clow Valve Co.
 - b. DeZurik.
 - c. Homestead Valve (Div. of Olson Technologies, Inc.).
 - d. Milliken Valve Co.
 - e. Val-Matic Valve and Manufacturing Co.
 - f. Victaulic Co.
 - 5. High-Performance Knife Gate Valves (HK):
 - a. ITT Engineered Valves (Fabri-valve).
 - 6. Ball Control Valves (BCV):
 - a. Fischer Controls Co., (Vee-Ball).
 - b. Hilliburton Co. (Dresser Valve Div., Masoneilan Product, Control Ball II).
 - 7. Electric motor open-shut service operators:
 - a. Limitorque Corp.
 - b. Rotork.

8. Electric motor operators for throttling service:
 - a. Limitorque Corp.
 - b. Rotork.
9. Floor Box:
 - a. Clow Valve Co.
 - b. Ludlow.
10. Limit Switches, spring-centered:
 - a. Allen-Bradley.
 - b. Square D Co.
11. T-handle Wrench:
 - a. Clow Valve Co.

2.02 VALVE AND GATE IDENTIFICATION

- A. Each valve and gate shall be tagged with its distinguishing mark letter and number. Mark letter and number will be as listed on Valve Schedule. Identification tag shall be 1-1/2-inch in diameter, 18-gauge polished brass or aluminum with 1/2-inch-high, embossed, black-filled mark letter and number placed thereon. Tags shall be securely fastened to the valve or gate operator with No. 16 brass jack chain or plastic seals.

2.03 COMPONENTS

- A. Resilient Seated Gate Valves (RA):
 1. Resilient seated gate valves shall be designed for 150 psi working pressure and shall meet the requirements of AWWA Specification C509 except as otherwise specified herein. Valves shall be cast or ductile iron body, bronze stem, O-ring stem seal, and non-rising stem. The interior and exterior surfaces of the valve body shall be coated with an epoxy coating meeting the requirements of AWWA C550. The bronze or iron or ductile iron wedge shall be fully encapsulated with molded rubber. No bare metal shall be left exposed. The valve shall seal on both sides of the wedge. Gate valves shall have a clear waterway equivalent in area, when fully open, to that of the connecting pipe. Valves shall be made to open when turned to the left, or counterclockwise. The gate valves shall have square wrench nuts mounted on non-rising stems. All fasteners shall be stainless steel. Ground-buried gate valves shall be furnished with valve boxes. Flanges shall meet the requirements of AWWA C115 (ANSI 21.15). Two complete sets of joint accessories shall be furnished with each valve.
 2. The force mains will be laid with a minimum 5 feet of cover or as noted on Drawings. One operating wrench of suitable length shall be provided under this Section.
- B. Standard Swing Check Valves (C):
 1. Standard swing check valves shall meet the requirements of ANSI/AWWA C508. In quality of material and workmanship, check valves shall fulfill the requirements of the specification set forth above for gate valves insofar as they are applicable to the construction of check valves. Check valves shall be cast iron body and fully bronze mounted with a bronze seating ring. Check valves shall be of the balanced single disc type with the disc hinged at the top, with outside lever and adjustable weight or spring. A clear waterway opening equal to the full area of the connecting pipe shall be provided when the valve is open.
 2. Disc on sizes smaller than 4 inches shall be solid bronze and on larger sizes shall be cast or ductile iron with elastomer facing. Hinge pins shall be stainless steel.

- C. Plug Valves (P):
 1. Plug valves shall be nonlubricated, eccentric type with nitrile butadiene (hycar) or Buna-N resilient faced plugs. End connections shall generally be flanged or grooved for inside valves and mechanical joint for exterior ground-buried valves. Port areas shall be equal to at least 80 percent of the nominal size pipe area. Valve bodies shall be suitably marked to indicate whether the valve is open or closed.
 2. The seating surface of the valve body shall be welded in stainless steel or nickel. Bearings at the top and bottom supporting the rotating element shall be self-lubricating, corrosion-resistant type, suitable for sewage plant service. The valve shall be of the bolted bonnet design. Packing shall be visible for inspection without dismantling valve or removing operator. The packing shall be adjustable and replaceable without disassembling of the valve. The valve body shall be cast or ductile iron marked to show seat side of valve.
 3. Plug valves shall be of adequate design to operate with a pressure of 50 psi on both sides or on either side of the valve without leakage.
- D. High-Performance Knife Gate Valves (HK):
 1. High-performance knife gate valves shall be the single-seated, bonneted wafer type with through bolting designed to fit between ANSI Class 125 flanges of the scheduled size. Wetted parts shall be 304 stainless steel unless otherwise listed on Valve Schedule or noted below. The valve pressure rating shall be 150 psi unless otherwise noted on Schedule.
 2. The bonnet shall be carbon steel with wetted surfaces of 304 stainless steel and shall have two 1/2-inch diameter, threaded ports with plugs unless otherwise noted on Valve Schedule.
 3. The valve stem shall be 304 stainless steel. The stem nut shall be acid resistant bronze mounted in the carbon steel yoke.
 4. Valve gate shall be 304 stainless steel, beveled to provide a wedging action to seal the gate against the seat and to aid in cutting through any accumulated solids and shall be finished on both sides to 32 rms. The gate shall seal against a stainless steel seat with a neoprene O-ring integrally mounted therein to aid in providing a positive seal.
 5. Packing shall be TFE/graphite, mounted around the stem on top of the bonnet. It shall be held in place by a carbon steel follower. Packing shall be replaceable without disassembling the bonnet.
 6. A graphite wiper assembly shall be mounted between the gate and the valve body to prevent solids from entering the bonnet housing.
 7. Valves shall be provided with one spare set of stem packing and shall be clearly marked to indicate the seat side of the valve.
- E. Ball Control Valves (BCV):
 1. Ball control valves shall be completely factory-assembled including appurtenances as listed on Valve Schedule.
 2. Valves shall be characterized, parabolic or vee, flangeless ANSI B16.1, Class 150, for mounting between flanges. Valves shall have carbon steel body, chrome-plated 316SS ball, reinforced Teflon seal meeting ANSI B16.1 Class V leakage minimum. Valves shall have splined and clamped shaft and lever arm, stainless steel shaft with outboard trunnion bearing and enclosed bracket and linkage.

2.04 VALVE JOINTS

- A. Bell and Spigot Lead: Bell lead joints shall meet the requirements of ANSI/AWWA C110/A21.10.
- B. Flange Joint: Flanges shall meet the requirements of ANSI-B16.1 Standard Class 125, except that bolt holes at shaft hubs may be drilled and tapped on the flanges. Flange faces shall be coated with a rust inhibitor immediately after drilling.

- C. Grooved Coupling: Grooved coupling joints shall be the rigid type and shall have housing fabricated in 2 or more parts of malleable iron in accordance with ASTM Specification A 47, Grade C32510. Ends shall be factory grooved in accordance with the coupling manufacturer's standard groove dimension. Bolts shall be oval neck track head type with hexagonal heavy nuts, per ASTM A 183 and A 194/A 194M. Gasket material shall be Grade H, E chlorinated butyl, or E.P.D.M. for water service and Grade T Buna-N for sewage.
- D. Mechanical joints shall conform to ANSI/AWWA C110/A 21.10 and ANSI/AWWA C111/A 21.11.
- E. Push-on joints shall conform to ANSI A21.11 and AWWA C111.
- F. Screwed joints shall conform to American Standard dimensions ANSI B16.3 and threads ANSI B2.1.
- G. Wafer joints shall be flat face or raised face for use between standard flanges.

2.05 ACCESSORIES

- A. Manual Operators: Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to the maintenance shall be easily accessible.
 - 1. Manual operators shall be so sized that a maximum of 80 pounds of rim force/pull is required for operation.
 - 2. Positions of operators shall be approved by ENGINEER.
 - 3. Valve shall be made to open when turned to the left or counterclockwise.
 - 4. The direction of the operator to open position shall be indicated on the operator.
 - 5. Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
 - 6. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
 - 7. Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
 - 8. Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
 - 9. Lever shall be fabricated steel, shall include a setscrew and be grease lubricated.
 - 10. Chain lever shall indicate chain and lever. Materials shall be galvanized.
 - 11. Infinite lever shall be of extra heavy steel and capable to be moved to any position and locked in place by a simple wing nut.
 - 12. Position lever shall be of extra heavy steel with a multiple position throttling plate.
 - 13. Wrench heads shall be cast iron with setscrew. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.
 - 14. Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.
- B. Motor:
 - 1. Electric Motor Open-Close Service: Electric motor operators for open-shut service shall meet the requirements of AWWA C504, Electric Operators, except as herein specified.
 - a. Controls shall be either "integrally mounted" in the valve body or separated from the valve body in a "wall-mounted" enclosure. The type to be supplied will be designated on Valve Schedule. Deviations from the Valve Schedule will not be accepted.

- b. Electrical equipment shall be mounted in a NEMA 4 or 7 enclosure whether on the valve body or in the wall-mounted enclosure. The enclosure shall be NEMA 4 unless shown otherwise on Valve Schedule.
- c. Motorized valve operators scheduled with integrally mounted controls in the valve body shall include the motor, reversing starter with remote-local switch, associated gearing, limit switches, torque switches, auxiliary handwheel for manual operation, a valve mounted mechanical dial valve position indicator, Open-Close-Stop push-buttons, and accessories as listed on Valve Schedule.
- d. Motorized valve operators scheduled with "wall-mounted" controls shall include the motor, reversing starter, and remote-local switch mounted in the valve body or the wall-mounted enclosure at the manufacturer's option, associated gearing, limit switches and torque switches mounted in the valve body, declutchable auxiliary handwheel for manual operation, a valve mounted mechanical dial valve position indicator, the wall-mounted control enclosure, and accessories as listed on Valve Schedule.
- e. The wall-mounted control enclosure shall include valve "open" (amber) and "closed" (green) indicating lights, a remote-local switch even if there is a remote-local switch at the valve body, Open-Stop-Close push-buttons and a terminal strip to accept incoming and outgoing wires.
- f. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
- g. The motor starters shall be the reversing contactor type complete with gang-operated switch, 2 mechanically interlocking reversing contactors, 120 volt control power transformer when motor voltage is other than 120 volt, thermal overload protection for each phase, and associated wiring. Operating voltage shall be as shown on Valve Schedule.
- h. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for the local indicator lights and interlocking. An additional 4 switches shall be provided for remote use.
- i. Torque switches shall be provided in both the open and closed circuits of the operators. The torque switches shall be field adjustable and designed to stop the operator motor when the torque exceeds safe limits for either the operator or the valve. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque seated valve.
- j. A local mechanical dial position indicator shall be provided on the valve operator to indicate the position of the valve.
- k. Motors shall be standard-duty rated, totally enclosed nonventilated, Class B insulated, 60 hertz with voltage and phase as noted on Valve Schedule, specially designed for valve service. The design shall combine low inertia with a high starting and stalling torque. The motors shall be sized to operate valves from full open to full closed in one to three minute cycles under the full specified unbalance operating head stated in the Specifications. The motor winding temperature rise shall be NEMA standard for Class B insulation at the rated service factor load.
- l. Gear case shall be cast iron. Pedestals shall be fabricated steel or cast iron. Stem nut shall be high-tensile bronze.
- m. Mechanical emergency operation in event of power failure shall be provided by a clutchable handwheel drive mechanism completely independent from the motor gearing. Hand operation shall be direct drive permitting fast manual valve operation. Failure of

motor gearing shall not prevent emergency handwheel operation. Manual operation shall prevent (disconnect) electrical operation.

2. Electric Motor Throttling Service:
 - a. Electric motor operator for throttling service on the valves shall meet the requirements of AWWA C504, Electric Operators, except as herein specified. Enclosures shall be NEMA 4 unless shown otherwise on Valve Schedule.
 - b. The valve operator torque shall be as required for a 150 psi pressure drop across the valve, minimum, except those for low pressure air service. The valve operator torque for low pressure air service valves shall be as required for a 25 psi pressure drop across the valve, minimum.
 - c. The housing and covers shall be of cast aluminum or cast iron. Mechanical parts shall be designed for safety factor of at least 2. Construction of the operator shall be such that it may be mounted in any position required to facilitate manual operation. Manual operation of the valves shall be possible by a handwheel attached to the mechanism. Power to motor circuit shall be automatically disconnected to prevent accidental electric operation during manual operation. A mechanical dial position indicator shall be provided to continuously indicate valve position. Operator bearings shall be self-lubricating type or lubricated for life before operator is sealed at the factory.
 - d. The operator motor shall be heavy-duty with continuous duty rating and totally enclosed and nonventilated. The motor shall be equipped with thermal overload protection. Operating voltage shall be as listed on Valve Schedule.
 - e. The winding temperature rise shall meet NEMA standard for the class of insulation used at the rated service factor load. The motor shall be for high torque variable speed duty. The motor shall be reversible. A 4-20 mA throttling signal shall be provided by others. Control interface electronics, motor controller, and appurtenances to accept this signal and position the valve between 0 and 90 degrees based on the value of the throttling signal shall be provided with the valve operator. The controller shall be provided complete with NEMA 4 enclosure, Auto-Manual selector switch and Open, Close push-buttons. Controller shall be completely solid state; contactors are not acceptable. Motor and controller shall be suitable for over 1,000 starts per hour. Controllers shall accept an isolated 4-20 mA signal for valve positioning from a remote source. Valve operators shall be equipped to be field adjustable to fail open, fail closed, or fail in place upon loss of control signal (4-20 mA). Valves shall be set up to fail in place unless otherwise noted on Valve Schedule.
 - f. The gear train shall be pre-selected to have open-close operating time from 1 to 3 minutes as shown on Valve Schedule.
 - g. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for a local indicator and interlocking. An additional switch shall be provided at each end for remote use.
 - h. Motor circuit limit switches shall be of the direct break type. Limit switches shall be adjustable. Limit switch contacts shall be isolated. Auxiliary switches for secondary functions shall be of the cam-operated, spring leaf type. The operator shall be equipped with a torque switch for protection in the closing direction. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque-seated valve. In the event of power failure, the operator shall lock in the last control position until power is restored or switched over to standby power or the manual operating handwheel is engaged.
 - i. Torque switches, limit switches, and motor thermal switches are to be mounted as required inside the housing and connected to the master terminal strip. Provisions shall be made for 2 internal potentiometers for feedback control operations and for remote valve position indicator. Wiring within operator shall be incorporated in a standard laced wiring harness

- using compression connectors and terminal strips. Internal wiring shall be UL approved for 105 degrees C operation. Insulation shall be suitable for 600 volts.
- j. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
- C. Bench Stand: Bench stands shall meet the requirements of floor stands as specified in this Section, except that baseplates shall replace pedestals.
 - D. Control Package: The control package shall consist of indicating lights, Open-Close-Stop push-button stations, Local-Remote control selector, strip headers, and wiring factory assembled, mounted in a NEMA 4 enclosure unless otherwise noted on Valve Schedule.
 - E. Extension Bonnet (Length): Extension bonnets shall be cast iron and be provided complete with galvanized assembly bolts.
 - F. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
 - 1. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.
 - G. Floor Box (Length): Where openings through concrete slabs are provided for key operation of valves and extension stems connected therewith, the operating nut being in or below the slab, such openings shall be provided with a floor box, complete with cover. Each floor box shall be of the depth required for installation as shown on Valve Schedule and shall have cast on the cover an appropriate name designating the service for which the valve is used. In addition, where the operating nut is in the slab, the floor box shall be bronze bushed; where below, the opening in the bottom of the box shall be sufficient for passage of the operating key.
 - 1. Each floor box and cover therefor shall be coated by dipping in hot asphaltum varnish.
 - H. Floor Stand: Floor stands shall meet the requirements of AWWA C501 for Manual Operating Mechanism except as specified in this Section.
 - 1. Floor stands shall be a high-strength cast iron pedestal type furnished with lubrication fittings and stainless steel, double-nutted anchor bolts.
 - 2. Geared floor stands shall have weatherproof housings.
 - 3. Floor stands shall be provided with a galvanized steel stem cover and position indicator, and the direction of rotation to open the valve shall be indicated.
 - 4. The operating stem will be 304 or 303 stainless steel.
 - 5. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand.
 - I. Position Indicator: Position indicators shall be of bronze or cast iron construction.
 - 1. Limit Switch. Two limit switches shall be factory-mounted to the valve for indicating full open and full closed positions.
 - J. Manual Screw: Manual screw operators shall meet the requirements of AWWA C504 operators.

- K. Remote Position Indicator: Remote position indicators shall be the isolated 1,000 ohm potentiometer design for use with a remote position indicator. Resolution of 1/2 percent shall be required and potentiometer shall be directly attached to or geared from the valve operating shaft.
- L. Stem Cover: Stem covers shall be galvanized steel with position indicators and cap.
- M. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B, construction with bronze bushings adjustable in two directions and provided with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.
- N. Valve Box (Length): Valve boxes shall be either cast iron or ABS plastic. Cast iron lids shall be provided with valve boxes and shall be marked "WATER" in raised letters.
 - 1. Cast iron boxes shall be of the 3-piece adjustable type. A Number 6 base shall be furnished with valves 8 inches or less, and a Number 160 base shall be provided for valves over 8 inches.
 - 2. ABS plastic boxes shall be of high-grade ABS polymer, two sections, adjustable to varying, desired grade levels by means of a friction design (upper section slides inside lower section), with base to fit various sized valves with arch.
 - 3. Plastic material shall meet requirements of ASTM D 1788.
 - 4. Cast iron material shall meet requirements of ASTM A 126-B or ASTM A 48, Class 30B.
 - 5. Bolt material shall meet requirements of ASTM B 316 and B 253.
 - 6. A magnet shall be permanently molded into both the upper and lower sections for easy locating with a dip needle or magnetic locator.
- O. Wall Bracket: Wall brackets shall be cast iron and provided with stainless steel assembly and anchor bolts.
- P. Worm Gear: Worm gear operators shall meet the requirements of AWWA C504 operators.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.
- B. Equipment furnished under this Section shall be installed under Section 15100.

3.02 FIELD QUALITY CONTROL

- A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section are installed in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 15460 - GENERAL SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Compressed air piping.
2. Unions and flanges.
3. Strainers.
4. Pipe hangers and supports.
5. Flexible connectors.
6. Compressed air outlets.
7. Hose connectors.
8. Underground pipe markers.

B. Related Requirements:

1. Section 07841 - Firestopping: Requirements for firestopping for placement by this Section.
2. Section 09960 - High Performance Coatings: Requirements for coatings as specified by this Section.
3. Section 15520 - Hangers and Supports for HVAC Piping and Equipment: Requirements for pipe hangers and supports and firestopping for placement by this Section.
4. Section 15530 - Identification for HVAC Piping and Equipment: Requirements for pipe identification for placement by this Section.
5. Section 15462 - General Service Compressed-Air Valves: Valves, pressure regulators, and accessories for use in compressed-air systems in plant applications.
6. Section 15464 - General Service Packaged Air Compressors and Receivers: Compressors, components, and accessories for use in compressed-air systems in plant applications.

1.02 REFERENCE STANDARDS

A. ASME International:

1. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
2. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
4. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
9. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
10. ASTM B88M - Standard Specification for Seamless Copper Water Tube.
11. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
12. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
13. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
14. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
15. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
16. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:

1. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.03 PREINSTALLATION MEETINGS

- A. Section 01300 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.04 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 - 1. Piping: Submit manufacturer information on pipe materials, fittings, and accessories.
 - 2. Hangers and Supports: Submit manufacturer catalog information, including load capacity.
 - 3. System Components: Submit manufacturer catalog information including capacity, component sizes, rough-in requirements, and service sizes.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01700 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of equipment piping, outlets, and components.
- C. Operation and Maintenance Data: Submit assembly views and replacement part numbers and availability.

1.06 QUALITY ASSURANCE

- A. Perform Work according to ASME B31.9 code for installation of piping systems.
- B. Perform Work according to AWS D1.1/D1.1M for welding of hanger and support attachments to building structure.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place, and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Keep plugged or capped ends sealed until installation.
3. Keep containers sealed until installation.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.09 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 COMPRESSED AIR PIPING

A. Stainless-Steel Piping:

1. Pipe:
 - a. Description: Certified for use with compression joint system.
 - b. Comply with ASTM A312/A312M; 0.049 wall.
 - c. Type: 304.
2. Fittings:
 - a. Description: Press type, precision cold-drawn austenitic stainless-steel fittings and couplings.
 - b. O-rings:
 - 1) Material: Nitrile.
 - 2) Comply with NSF 61.
3. Joints: Compression type made with manufacturer's tool.

2.02 UNIONS AND FLANGES

A. Unions for Pipe 2 Inches and Smaller:

1. Stainless-Steel Piping:

- a. Maximum Working Pressure: 300 psig.
- b. Type: Threaded.
- c. End Connections: Compression type.

2.03 STRAINERS

A. ST-1; 2 Inches and Smaller:

- 1. Pattern: "Y."
- 2. Body: Bronze; ASTM B62.
- 3. End Connections:
 - a. Type: Threaded.
 - b. Class 150.
- 4. Screen:
 - a. Material: Stainless steel.
 - b. Type: Perforated.
 - c. Mesh Size:
 - 1) 1/16 inch.

2.04 PIPE HANGERS AND SUPPORTS

A. Comply with ASME B31.9 and MSS SP-58.

B. Hangers:

- 1. Pipe Sizes 1/2 Inch to 1-1/2 Inches:
 - a. Material: Stainless steel.
 - b. Type: Adjustable swivel; split ring.

C. Supports:

- 1. Wall:
 - a. Pipe Sizes 3 Inches and Smaller: Stainless steel wall clamp.
- 2. Vertical Support: Stainless steel riser clamp.
- 3. Floor Support for Cold Pipe: adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.

2.05 FLEXIBLE CONNECTORS

A. 2 Inches and Smaller:

1. Description: Corrugated stainless-steel hose with single layer of stainless-steel exterior braiding.
2. Ends: Stainless steel.
3. Maximum Working Pressure: 170 psig.
4. End Connections: Threaded or soldered.

2.06 COMPRESSED AIR OUTLETS

A. Description:

1. Snap-on "quick" connector with self-closing valve.
2. Material: Brass.
3. Size: 3/8 inch.
4. Style: M.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01700 - Execution and Closeout Requirements: Requirements for installation examination.

3.02 PREPARATION

- A. Section 01700 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Ream pipe and tube ends and remove burrs.
- C. Remove scale and dirt from inside and outside of pipe and fittings before assembly.
- D. Prepare piping connections to equipment with flanges or unions.
- E. Keep open ends of pipe free from scale and dirt.

3.03 INSTALLATION

A. Inserts:

1. Provide for placement in concrete forms.
2. Provide for suspending hangers from reinforced concrete slabs, and for sides of reinforced concrete beams.
3. Concrete Slabs Forming Finished Ceiling: Locate inserts flush with slab surface.
4. If inserts are omitted, drill through concrete slab from below and provide through bolt with recessed square steel plate and nut above slab.

B. Hangers and Supports:

1. Comply with, ASME B31.9, and MSS SP-58.
2. Provide minimum 1/2-inch space between finished covering and adjacent Work.
3. Hangers:
 - a. Place within 12 inches of each horizontal elbow.
 - b. Minimum Vertical Adjustment: 1-1/2 inches.
 - c. Design hangers for pipe movement without disengagement of supported pipe.
 - d. Where piping is installed in parallel and at same elevation, provide multiple-pipe or trapeze hangers.
4. Supports:
 - a. Horizontal Piping: As indicated in schedule following END OF SECTION.
 - b. Vertical Piping:
 - 1) Riser Piping: Independent of connected horizontal piping.
5. Prime coat exposed steel hangers and supports as specified in Section 09960 - High Performance Coatings. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
6. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

C. Aboveground Piping:

1. Install drip connections with valves at low points of piping system.
2. Takeoffs:
 - a. Install takeoff to outlets from top of main, with shutoff valve after takeoff.
 - b. Slope takeoff piping to outlets.
3. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.
4. Changes in Direction:
 - a. Install tees instead of elbows at changes in direction of piping.
 - b. Fit open end of each tee with plug.
5. Cut pipe and tubing accurately and install without springing or forcing.
6. Slope piping in direction of flow.
7. Stainless-Steel Pipe with Press-Type Joints:
 - a. Square cut ends to plus or minus 0.030 inch tolerance.
 - b. Remove burrs and clean ends.
 - c. Fully insert tubing into fitting and mark pipe ends to ensure full insertion into coupling or fitting during assembly.
 - d. Press joint using manufacturer's tool with properly sized jaw.

8. Pipe Sleeves:
 - a. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions.
 - b. As specified in Section 15520 - Hangers and Supports for HVAC Piping and Equipment.
9. Firestopping:
 - a. Install firestopping at fire-rated construction perimeters and openings containing penetrating sleeves and piping.
 - b. As specified in Section 07840 - Firestopping.
10. Pipe Identification: As specified in Section 15530 - Identification for HVAC Piping and Equipment.
11. Except where indicated, install manual shutoff valves with stem vertical and accessible for operation and maintenance.
12. Strainers:
 - a. Install strainers on inlet side of pressure-reducing valves.
 - b. Install strainers on inlet side of pressure regulators.
13. Install pressure-reducing valves with bypasses and isolation valves to allow maintenance without interruption of service.

3.04 FIELD QUALITY CONTROL

- A. Section 01700 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Inspection: Verify atmospheric pressure in piping systems, other than system under test.
- C. Testing:
 1. Test system with dry compressed air or dry nitrogen.
 2. Test Pressure: 50 psig.
- D. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.05 CLEANING

- A. Section 01700 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Blow systems clear of moisture and foreign matter.

3.06 ATTACHMENTS

A. Pipe Hanger Spacing:

1. Pipe Size 1/2 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
2. Pipe Size 3/4 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
3. Pipe Size 1 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
4. Pipe Size 1-1/4 Inches:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
5. Pipe Size 1-1/2 Inches:
 - a. Maximum Hanger Spacing: 9 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
6. Pipe Size 2 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
7. Pipe Size 2-1/2 Inches:
 - a. Maximum Hanger Spacing: 11 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
8. Pipe Size 3 Inches:
 - a. Maximum Hanger Spacing: 12 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
9. Pipe Size 4 Inches:
 - a. Maximum Hanger Spacing: 14 feet.
 - b. Hanger Rod Diameter: 5/8 inch.

END OF SECTION

SECTION 15505 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections.
- B. Related Sections:
 - 1. Section 16060 - Grounding and Bonding for Electrical Systems.
 - 2. Section 16075 - Identification for Electrical Systems.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- C. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: As indicated on Drawings.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.
- D. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 - 2. Voltage: 115/230 volts, single phase, 60 Hz.
- E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.02 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned motors.

- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

3.02 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.
- B. Install engraved plastic nameplates in accordance with Section 16075.
- C. Ground and bond motors in accordance with Section 16060.

3.03 FIELD QUALITY CONTROL

- A. Section 01770 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 15520 - HANGERS AND SUPPORTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hanger rods.
2. Inserts.
3. Flashing.
4. Equipment curbs.
5. Sleeves.
6. Mechanical sleeve seals.
7. Equipment bases and supports.

B. Related Requirements:

1. Section 03100 - Concrete Forming and Accessories: Placement of inserts sleeves in concrete forms as required by this Section.
2. Section 03300 - Cast-in-Place Concrete: Placement of concrete housekeeping pads as required by this Section.
3. Section 07900 - Joint Protection: Sealant materials for placement by this Section.
4. Section 09900 - Painting and Coating: Painting as required by this Section.
5. Section 09960 - Chemical-Resistant Coatings: Painting as required by this Section in designated areas subject to chemical corrosion.

1.02 REFERENCE STANDARDS

A. American Welding Society:

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

B. ASME International:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
3. ASME B31.9 - Building Services Piping.

C. ASTM International:

1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
3. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. FM Global:

1. FM - Approval Guide.

E. Intertek Testing Services (Warnock Hersey Mark):

1. WH-ETL - Product Directory.

- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

- G. UL:
 - 1. UL - Fire-resistance-rated Systems and Products.
 - 2. UL 263 - Fire Tests of Building Construction and Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Requirements for submittals.

- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturer's catalog information, including load capacity.

- C. Shop Drawings:
 - 1. Indicate system layout with location, including critical dimensions and sizes.
 - 2. Indicate pipe hanger and support locations, and detail of trapeze hangers.

- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- E. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load-carrying capacity of trapeze, multiple-pipe, and riser support hangers.
 - 2. Submit sizing methods and calculations sealed by a registered professional engineer (P.E.).

- F. Manufacturer Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.

- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics:
 - 1. Maximum 25/450 flame-spread/smoke-developed index.
 - 2. Testing: Comply with ASTM E84.

- B. Welding of Hanger and Support Attachments to Building Structure: Comply with AWS D1.1/D1.1M.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

- B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.07 AMBIENT CONDITIONS

- A. Section 01500 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Provide ventilation in areas to receive solvent cured materials.

1.08 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.09 WARRANTY

- A. Section 01770 - Contract Closeout: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.01 INSERTS

- A. Description:
 - 1. Malleable iron case with galvanized steel shell and expander plug for threaded connection.
 - 2. Lateral adjustment, top slot for reinforcing rods, and lugs for attaching to forms.
 - 3. Size: To suit threaded hanger rods.

2.02 FLASHING

- A. Metal Flashing:
 - 1. Material: Galvanized steel.
 - 2. Thickness: 26 gage.
- B. Metal Counterflashing:
 - 1. Material: Galvanized steel.
 - 2. Thickness: 22 gage.
- C. Sheet Lead Flashing:
 - 1. Waterproofing: 5 psf.
 - 2. Soundproofing: 1 psf.
- D. Flexible Flashing:
 - 1. Material:
 - a. Sheet butyl.
 - b. Compatible with roofing.
 - 2. Thickness: 47 mils.
- E. Caps:
 - 1. Material: Steel.
 - 2. Minimum Thickness:
 - a. 22 gage.
 - b. 16 gage at fire-resistive elements.

2.03 EQUIPMENT CURBS

- A. Description:
 - 1. Shell and Base: Welded 18-gage galvanized steel.
 - 2. Cant: Mitered; 3 inches.
 - 3. Wood Nailer: Factory installed.

2.04 SLEEVES

- A. Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gage galvanized steel.
- B. Round Ductwork: Galvanized steel.
- C. Rectangular Ductwork: Galvanized steel or wood.
- D. Sealant:
 - 1. Material: Acrylic.

2.05 MECHANICAL SLEEVE SEALS

- A. Description:
 - 1. Type: Modular mechanical.

2. Configuration: Interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
3. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and insulation.

2.06 FORMED STEEL CHANNEL

- A. Description:
1. Material: Galvanized 12-gage steel.
 2. Thickness: 12 gage.
 3. Hole Spacing: 1-1/2 inches o.c.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01770 – Contract Closeout: Requirements for installation examination.
- B. Verify that openings are ready to receive sleeves.

3.02 PREPARATION

- A. Section 01770 – Contract Closeout: Requirements for installation preparation.
- B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that may affect bond of firestopping material.
- C. Remove incompatible materials that may affect bond.
- D. Install backing materials to arrest liquid material leakage.
- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Do not drill or cut structural members.

3.03 INSTALLATION

- A. Inserts:
1. Install inserts for placement in concrete forms.
 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
 4. If concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. If inserts are omitted, drill through concrete slab from below and provide through bolt with recessed square steel plate and nut flush with top of slab.
- B. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete as specified in Section 03300 - Cast-in-Place Concrete.
2. Minimum Size: 3-1/2 inches thick and extending 6 inches beyond supported equipment.
3. Use templates furnished with equipment to install equipment anchor bolts and accessories.
4. Supports:
 - a. Material: Steel members.
 - b. Brace and fasten with flanges bolted to structure.

C. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
2. Curbs:
 - a. Provide curbs for roof installations with minimum height of 14 inches above roofing surface.
 - b. Flash and counterflash with sheet metal and seal watertight.
 - c. Attach counterflashing to equipment and lap base flashing on roof curbs.
 - d. Flatten and solder joints.
3. Storm Collars:
 - a. Adjust storm collars tight to pipe with bolts and calk around top edge.
 - b. Install storm collars above roof jacks.
 - c. Screw vertical flange section to face of curb.

D. Sleeves:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals.
2. Set sleeves in position in forms and provide reinforcing around sleeves.
3. Sizing:
 - a. Size sleeves large enough to allow for movement due to expansion and contraction.
 - b. Provide for continuous insulation wrapping.
4. Spaces:
 - a. If piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing insulation and calk.
 - b. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
 - c. Install chrome-plated steel escutcheons at finished surfaces.

3.04 FIELD QUALITY CONTROL

- A. Section 01770 – Contract Closeout: Requirements for testing, adjusting, and balancing.

3.05 CLEANING

- A. Section 01770 – Contract Closeout: Requirements for cleaning.

3.06 PROTECTION

- A. Section 01770 – Contract Closeout: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.07 ATTACHMENTS

- A. Pipe Hanger Spacing:
1. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches and smaller.
 - b. Maximum Hanger Spacing: 6 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 2. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches and larger.
 - b. Maximum Hanger Spacing: 10 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 3. Pipe Material: Steel.
 - a. Size: 3 inches and smaller.
 - b. Maximum Hanger Spacing: 12 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 4. Pipe Material: Steel.
 - a. Size: 4 inches and larger.
 - b. Maximum Hanger Spacing: 12 feet.
 - c. Hanger Rod Diameter: 5/8 inch.

END OF SECTION

SECTION 15525 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Inertia bases.
2. Vibration isolators.
3. Ductwork lagging.

B. Related Requirements:

1. Section 03300 - Cast-in-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this Section and product requirements for concrete for placement by this Section.
2. Section 07900 - Joint Protection: Product requirements for joint sealers specified for placement by this Section.
3. Section 15510- Expansion Fittings and Loops for HVAC Piping: Product requirements for anchors and piping expansion compensation.
4. Section 15520 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
5. Section 15980 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this Section.
6. Section 15810 - HVAC Ducts and Casings: Vibration isolation devices for ducts and casings.
7. Section 15820 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct sound attenuators specified for placement by this Section.

1.02 REFERENCE STANDARDS

A. Air Movement and Control Association International, Inc.:

1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. Air-Conditioning, Heating, and Refrigeration Institute:

1. AHRI 575 - Method of Measuring Machinery Sound within an Equipment Space.

C. American National Standards Institute:

1. ANSI S1.4 - Specification for Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Measurement of Sound Pressure Levels in Air.
4. ANSI S12.60 - Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 68 - Laboratory Method of Testing to Determine the Sound Power in a Duct.
2. ASHRAE Handbook - HVAC Applications.

- E. ASTM International:
 - 1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 2. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 - 3. ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.
- F. Sheet Metal and Air Conditioning Contractors' National Association:
 - 1. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 - 1. Submit schedule of vibration isolator type with location and load on each.
 - 2. Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- C. Shop Drawings:
 - 1. Indicate static and dynamic load of both inertia bases and vibration isolators.
 - 2. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for fabricated sound attenuation products.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions:
 - 1. Submit special procedures and setting dimensions.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Manufacturer Reports: Certify that sound isolation installation is complete and complies with instructions.
- H. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, installer, and licensed professional.
 - 2. Submit manufacturer's approval of installer.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600- Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.06 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.07 WARRANTY

- A. Section 01770 – Contract Closeout: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for inertia bases.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

- A. Provide vibration isolation devices on motor-driven equipment over 0.5 hp, plus connected piping and ductwork.
- B. Minimum Static Deflection of Isolators:
 - 1. Under 20 hp.
 - a. 400 to 600 rpm: 1.0 inch
 - b. 600 to 800 rpm: 0.5 inch
 - c. 800 to 900 rpm: 0.2 inch
 - d. 1,100 to 1,500 rpm: 0.15 inch
 - e. Over 1,500 rpm: 0.1 inch
 - 2. Over 20 hp.
 - a. 400 to 600 rpm: 2.0 inches
 - b. 600 to 800 rpm: 1.0 inch
 - c. 800 to 900 rpm: 0.5 inch
 - d. 1,100 to 1,500 rpm: 0.2 inch
 - e. Over 1,500 rpm: 0.15 inch
- C. Consider upper floor locations critical unless otherwise indicated.

- D. Use concrete inertia bases for fans having static pressure greater than 3.5-inch wg, motors larger than 40 hp, and on base-mounted pumps larger than 10 hp.
- E. Maintain indicated maximum sound level of spaces by using acoustical devices.

2.02 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Kinetics Noise Control.
 - 2. Approved equivalent.
- B. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 - 2. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 - 3. Spring Mounts: Furnish leveling devices, minimum 0.25-inchthick neoprene sound pads, and zinc chromate-plated hardware.
 - 4. Sound Pads:
 - a. Size: Based on minimum deflection of 0.05 inch.
 - 5. As specified for neoprene pad isolators.
 - 6. Restraints: Furnish mounting frame and limit stops.
- C. Spring Hangers:
 - 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 - 2. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 - 3. Housings: Incorporate neoprene isolation pad as specified for neoprene pad isolators.
 - 4. Misalignment: Capable of 20-degree hanger rod misalignment.
- D. Neoprene Pad Isolators:
 - 1. Rubber or neoprene-waffle pads.
 - a. Hardness: 30 durometer.
 - b. Minimum Thickness: 1/2 inch.
 - c. Maximum Loading: 40 psi.
 - d. Rib Height: Not greater than 0.7 times width.
 - 2. Configuration: Single layer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01770 – Contract Closeout: Requirements for installation examination.
- B. Verify that equipment, ductwork, and piping are installed before starting Work of this Section.

3.02 PREPARATION

- A. Section 01770 – Contract Closeout: Requirements for installation preparation.
- B. Existing Work:
 - 1. Provide access to existing piping and ductwork and other installations remaining active and requiring access.
 - 2. Extend existing piping and ductwork installations using materials and methods compatible with existing installations.

3.03 INSTALLATION

- A. Install isolation for motor-driven equipment.
- B. Bases:
 - 1. Steel: Provide 1 inch of clearance between housekeeping pad and base.
- C. Make equipment level.
- D. Install spring hangers without binding.
- E. Isolators:
 - 1. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load to allow shim removal.
- F. Provide pairs of horizontal limit springs on fans with more than 6.0 inches of static pressure and on hanger-supported, horizontally mounted axial fans.
- G. Snubbers:
 - 1. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers.
 - 2. Provide each inertia base with minimum of four seismic snubbers located close to isolators.
 - 3. Equipment Designated for Post-Disaster: Snub to 0.05-inch maximum clearance.
 - 4. Other Snubbers: Provide clearance between 0.15 and 0.25 inch.
- H. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4-Inch Diameter: First three points of support.

3.04 FIELD QUALITY CONTROL

- A. Section 01770 – Contract Closeout: Requirements for testing, adjusting, and balancing.

- B. Inspect isolated equipment after installation and submit report, including static deflections.
- C. Testing Agency:
 - 1. Furnish services of testing agency to take noise measurement.
 - 2. Use meters according to ANSI S1.4.

END OF SECTION

SECTION 15540 - HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:

1. Section 07840 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09900 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
10. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
11. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
12. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
13. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
14. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
15. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

16. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
19. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
20. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
21. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
22. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
23. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
24. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors?:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:

1. UL 1978 - Standard for Safety for Grease Ducts.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for man made fiber.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Armacell AP Armaflex.
 - 2. Manville – Aerotube.
 - 3. Rubatex.
 - 4. Keene Corp., Fibrelite.
 - 5. Manville, Microlite.
 - 6. Owens/Corning Fiberglass.

2.02 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
 - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
- B. PVC Plastic Pipe Jacket:
 - 1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
 - 2. Thickness: 10 mil.

3. Connections: Pressure sensitive color matching vinyl tape.

C. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.016 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

D. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Blanket: 1.0 lb/cu ft density.
 - c. Weave: 10 x 10.
3. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.03 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.04 DUCTWORK INSULATION

A. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.

1. Density: 3.0 pound per cubic foot.

2.05 DUCTWORK INSULATION JACKETS

- A. Aluminum Duct Jacket:
 - 1. ASTM B209 .
 - 2. Thickness: 0.016 inch thick sheet.
 - 3. Finish: Embossed.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- B. Vapor Retarder Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film 0.0032 inch vinyl.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 - 3. Secure with pressure sensitive tape.

2.06 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Adhesive: Waterproof, ASTM E162 fire-retardant type.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- G. Adhesives: Compatible with insulation.
- H. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07840 for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Glass Fiber Board Insulation:
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.
- E. Inserts and Shields:
 - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- F. Insulation Terminating Points:
 - 1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
 - 2. Condensate Piping: Insulate entire piping system and components to prevent condensation.
- G. Closed Cell Elastomeric Insulation:
 - 1. Push insulation on to piping.
 - 2. Miter joints at elbows.
 - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 4. When application requires multiple layers, apply with joints staggered.

- 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with aluminum jacket.
- I. Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.
- J. Prepare pipe insulation for finish painting. Refer to Section 09900.

3.03 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F Or Less:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- G. Cover glass fiber insulation with aluminum jacket.
- H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- J. Prepare equipment insulation for finish painting. Refer to Section 09900.

3.04 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Ductwork Exposed in Mechanical Equipment Rooms: Finish with aluminum jacket.
- E. External Glass Fiber Duct Insulation:
 - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 - 2. Secure insulation without vapor retarder with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- F. External Elastomeric Duct Insulation:
 - 1. Adhere to clean oil-free surfaces with full coverage of adhesive.
 - 2. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 3. When application requires multiple layers, apply with joints staggered.
 - 4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
 - 5. Lift ductwork off trapeze hangers and insert spacers.
- G. Ducts Exterior to Building:
 - 1. Install insulation according to external duct insulation paragraph above.
 - 2. Provide external insulation with vapor retarder jacket. Cover with with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
 - 3. Finish with aluminum duct jacket.
 - 4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.
- H. Prepare duct insulation for finish painting. Refer to Section 09900.

END OF SECTION

SECTION 15610

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural gas piping above grade.
2. Unions and flanges.
3. Valves.
4. Pipe hangers and supports.
5. Strainers.
6. Natural gas pressure regulators.
7. Natural gas pressure relief valves.

B. Related Sections:

1. Section 05120 - Structural Steel Framing: Product requirements for touch-up painting of structural steel.
2. Section 05210 - Steel Joist Framing: Product requirements for touch-up painting of steel joists.
3. Section 07840 - Firestopping: Product requirements for firestopping for placement by this section.
4. Section 08310 - Access Doors and Frames: Access doors for concealed valves and accessories.
5. Section 09900 - Painting and Coating: Product requirements for painting for placement by this section.
6. Section 15500 - Pipes and Tubes for HVAC Piping and Equipment: Piping materials for gas piping systems.
7. Section 15515 - General-Duty Valves for HVAC Piping: Valves for gas piping systems.
8. Section 15520 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
9. Section 15530 - Identification for HVAC Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.
10. Section 02055 - Soils for Earthwork: Soils for backfill in trenches.
11. Section 02060 - Aggregates for Earthwork: Aggregate for backfill in trenches.
12. Section 02315 - Excavation: Product and execution requirements for excavation and backfill required by this section.
13. Section 02315 - Trenching: Execution requirements for trenching required by this section.
14. Section 02315 - Fill: Requirements for backfill to be placed by this section.
15. Section 02550 - Natural-Gas Distribution: Product and execution requirements for site natural gas distribution systems.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

- B. American Society of Mechanical Engineers:
 - 1. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
 - 4. ASME B31.9 - Building Services Piping.
 - 5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

- C. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - 5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
 - 6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

- D. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

- E. American Water Works Association:
 - 1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 67 - Butterfly Valves.
 - 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

- G. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.

- H. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use plug, or ball, valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.04 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Test Reports: Indicate results of piping system pressure test.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01700 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, piping system, and system components.

- C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists,.

1.06 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- C. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for valves excluding packing.

1.11 EXTRA MATERIALS

- A. Section 01700 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each type and size valve.

PART 2 - PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.02 Regulator Vent PIPING, ABOVE GRADE

- A. Indoors: Same as natural gas piping, above grade.
- B. Outdoors: PVC pipe, tubing, and fittings, UL 651.

2.03 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with soldered.
 - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
 - 2. Copper Piping: Class 150, slip-on bronze flanges.
 - 3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.04 BALL VALVES

- A. Manufacturers:
 - 1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 2. Crane; a Crane Co. brand.
 - 3. DynaQuip Controls.
 - 4. Flow-Tek, Inc.
 - 5. FNW; Ferguson Enterprises, Inc.
 - 6. Hammond Valve.
 - 7. IPEX USA LLC.
 - 8. Jamesbury; Metso.
 - 9. Jenkins Valves; a Crane Co. brand.
 - 10. Jomar Valve.
 - 11. KITZ Corporation.
 - 12. Legend Valve & Fitting, Inc.
 - 13. Marwin Valve; Richards Industries.
 - 14. Milwaukee Valve Company.
 - 15. NIBCO INC.
 - 16. Red-White Valve Corp.

17. Stockham; a Crane Co. brand.
18. Zurn Industries, LLC.
19. Substitutions: Section 01630 - Product Options and Substitutions.

- B. 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.
- C. 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.05 PLUG VALVES

- A. Manufacturers:
 1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 2. Crane; a Crane Co. brand.
 3. DynaQuip Controls.
 4. Flow-Tek, Inc.
 5. FNW; Ferguson Enterprises, Inc.
 6. Hammond Valve.
 7. IPEX USA LLC.
 8. Jamesbury; Metso.
 9. Jenkins Valves; a Crane Co. brand.
 10. Jomar Valve.
 11. KITZ Corporation.
 12. Legend Valve & Fitting, Inc.
 13. Marwin Valve; Richards Industries.
 14. Milwaukee Valve Company.
 15. NIBCO INC.
 16. Red-White Valve Corp.
 17. Stockham; a Crane Co. brand.
 18. Zurn Industries, LLC.
 19. Substitutions: Section 01630 - Product Options and Substitutions.
- B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated.

2.06 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 54, ASME 31.9, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.

- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe 3 inches and Smaller: Cast iron hook.
- F. Vertical Support: Steel riser clamp.
- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- H. Sheet Lead: ASTM B749, 2.5 lb/sq. ft. inch thick.

2.07 STRAINERS

- A. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- B. 2-1/2 inches to 4 inches: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.08 NATURAL GAS PRESSURE REGULATORS

- A. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 1. Comply with ANSI Z21.80.
 2. Temperatures: minus 20 degrees F to 150 degrees F.
 3. Body: Cast iron.
 4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 5. Disk, diaphragm, and O-ring: Nitrile.
 6. Maximum inlet pressure: 150 psig.
 7. Furnish sizes 2 inches and smaller with threaded ends.

2.09 NATURAL GAS PRESSURE RELIEF VALVES

- A. Product Description: Spring loaded type relief valve.
 1. Body: Aluminum.
 2. Diaphragm: Nitrile.
 3. Orifice: Stainless steel.
 4. Maximum operating temperature: 150 degrees F.
 5. Inlet Connections: Threaded.
 6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

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- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION - INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.9 and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.04 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- G. Group piping whenever practical at common elevations.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Sleeve pipe passing through partitions, walls and floors. Refer to Section 15520.
- J. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07840.
- K. Provide clearance for installation of insulation and access to valves and fittings.
- L. Provide access where valves and fittings are not exposed.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- N. Provide support for utility meters in accordance with requirements of utility company.
- O. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
 - 1. Minimum Vent Size: Connection size at regulator vent connection.
 - 2. Run individual vent line from each relief device, independent of breather vents.
- P. Breather vents may be manifolded together with piping sized for combined appliance vent requirements.
- Q. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09900.
- R. Install identification on piping systems including underground piping. Refer to Section 15530.
- S. Install valves with stems upright or horizontal, not inverted.
- T. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

- U. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- V. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- W. Provide new gas service complete with gas meter and regulators. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.05 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.
- C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.
- D. Pressure test natural gas piping in accordance with NFPA 54.
- E. Where new branch piping is extended from existing system, pressure test new branch piping only. Leak test joint between new and existing piping with noncorrosive leak detection fluid or other approved method.
- F. When pressure tests do not meet specified requirements, remove defective work, replace and retest.
- G. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
 - 1. Where leakage is detected, shut off gas supply until necessary repairs are complete.
- H. Do not place appliances in service until leak testing and repairs are complete.

3.06 SCHEDULES

- A. Steel Pipe Hanger Spacing:
 - 1. Pipe Size 1/2 Inch:
 - a. Maximum Hanger Spacing: 6 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 2. Pipe Size 3/4 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 3. Pipe Size 1 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 4. Pipe Size 1-1/4 Inches:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.

5. Pipe Size 1-1/2 Inches:
 - a. Maximum Hanger Spacing: 9 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
6. Pipe Size 2 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
7. Pipe Size 2-1/2 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
8. Pipe Size 3 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
9. Pipe Size 4 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
10. Pipe Size 5 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
11. Pipe Size 6 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 3/4 inch.
12. Pipe Size 8 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 5/8 inch.

END OF SECTION

SECTION 15718 - FUEL-FIRED HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Gas fired unit heaters.
- B. Related Sections:
 - 1. Section 15505 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
 - 2. Section 15520 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
 - 3. Section 15525 - Vibration Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 4. Section 15610 - Facility Natural-Gas Piping: Product requirements for natural gas piping connected to gas-fired heaters.
 - 5. Section 15820 - Air Duct Accessories: Product requirements for flexible duct connections.
 - 6. Section 16100 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z83.8 - Gas Unit Heaters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
 - 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittals procedures.
- B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

- D. Manufacturer's Installation Instructions: Submit Indicate rigging and assembly.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01770 - Contract Closeout: Closeout procedures.
- B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.05 QUALITY ASSURANCE

- A. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Product storage and handling requirements.
- B. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for heat exchanger.

1.10 EXTRA MATERIALS

- A. Section 01770 - Contract Closeout: Spare parts and maintenance products.
- B. Furnish two throwaway filters for each unit.

PART 2 - PRODUCTS

2.01 GAS FIRED UNIT HEATERS

- A. Manufacturers:
 - 1. Reznor.
 - 2. Modine.
 - 3. Marley.
 - 4. Approved Equal.
- B. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
 - 1. Heating fuel: Natural gas fired.
 - 2. Discharge Louvers: Individually adjustable horizontal louvers to match cabinet finish.
 - 3. Downturn Nozzle: 60 degree nozzle to match outlet and cabinet finish.
 - 4. Poly-Tube Outlet Adapter: Transition duct to adapt from unit outlet to round outlet flange for polyethylene tube duct.
 - 5. Air Filters: Filter cabinet with 1 inch thick glass fiber, disposable type filters.
 - 6. Gas Control: Single stage.
 - 7. Ignition System: Electric ignition-pilot to main burner.
 - 8. Control Voltage: 24 volt, 60 hertz.
 - 9. Location: Suspended overhead.
- C. Cabinet: Galvanized steel, easily removed and secured access panels, insulated or double panel construction.
- D. Supply Fan: Propeller type with direct drive.
- E. Heat Exchanger: Aluminized steel welded construction.
- F. Gas Burner: Power-vented with non-corrosive air blower with permanently lubricated motor.
- G. Gas Burner Safety Controls:
 - 1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - 2. Flame rollout switch: Installed on burner box and prevents operation.
 - 3. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - 4. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.

- H. Controls:
 - 1. Room Thermostat: Adjustable, low voltage, to control burner operation, and supply fan to maintain temperature setting. Include system selector switch (heat-off-cool) and fan control switch (auto-on).
 - 2. Supply Fan Control: Energize either from discharge temperature independent of burner controls or with timed off delay and timed on delay. Furnish manual switch for continuous fan operation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify space is ready for installation of units and openings are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install units in accordance with NFPA 90B gas fired units to NFPA 54.
- B. Installation - Natural Gas Piping:
 - 1. Connect natural gas piping in accordance with NFPA 54.
 - 2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
 - 3. Install the following piping accessories on natural gas piping connections. Refer to Section 15610.
 - a. Strainer.
 - b. Pressure gage.
 - c. Shutoff valve.
 - d. Pressure reducing valve.
- C. Install vent connections in accordance with NFPA 211. Install vents and stacks. Refer to Section 15590.
- D. Install unit heaters with vibration isolation. Refer to Section 15525.
- E. Provide hangers and supports for suspended units. Support infrared radiant heaters in fixed position.
- F. Provide hangers and supports for suspended units. Refer to Section 15520.
- G. Provide operating controls. Refer to Section 15900.
- H. Provide connection to electrical power systems. Refer to Section 16100.

END OF SECTION

SECTION 15723 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR
UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes outdoor, indirect, gas-fired, heating-only, makeup air units, including the following components:
 - 1. Casings.
 - 2. Outdoor-air intake hood.
 - 3. Roof curbs.
 - 4. Fans, drives, and motors.
 - 5. Air filtration.
 - 6. Dampers.
 - 7. Indirect, gas-fired burners.
 - 8. Unit control panel.
 - 9. Controls.
 - 10. Accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each outdoor, indirect, gas-fired, heating-only, makeup air unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.
 - c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
 - 5. Include filters with performance characteristics.
 - 6. Include direct, gas-fired burners with performance characteristics.
 - 7. Include dampers, including housings, linkages, and operators.

- B. Shop Drawings: For each outdoor, indirect, gas-fired heating and ventilating unit.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Startup service reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For indirect, gas-fired, makeup air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each unit.
 - 2. Gaskets: One set(s) for each access door.

1.7 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: Not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 CAPACITIES AND CHARACTERISTICS: Refer to Drawing Schedules.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CaptiveAire Systems.
 - 2. Greenheck Fan Corporation.
 - 3. Modine Manufacturing Company.
 - 4. REZNOR, a brand of Nortek Global HVAC.
 - 5. Sterling HVAC Products; a Mestek company.
 - 6. Weather-Rite, a brand of Specified Air Solutions.

2.4 UNIT CASINGS

- A. General Fabrication Requirements for Casings:
 - 1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
 - 2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
 - 3. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
- B. Configuration: Horizontal unit with horizontal discharge for concrete-base installation.
- C. Double-Wall Construction:
 - 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick, with high performance polyester coating rated for 5,000 salt spray test per ASTM B117, manufacturer's standard color.
 - 2. Inside Casing Wall:

- a. Inside Casing, Burner Section: Galvanized steel, solid, minimum 14-gauge thick steel.
 - b. Inside Casing, All Other Sections: Galvanized steel solid steel.
 - 3. Floor Plate: Galvanized steel , minimum 18 gauge thick.
 - 4. Casing Insulation:
 - a. Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071.
 - b. Insulation Thickness: 1 inch.
 - c. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
 - 5. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Panels and Doors:
- 1. Panels:
 - a. Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.
 - 2. Doors:
 - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.
 - 3. Locations and Applications:
 - a. Fan Section: Doors and inspection and access panels.
 - b. Access Section: Doors.
 - c. Gas-Fired Burner Section: Doors.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

2.5 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Filter: Aluminum, 2 inch cleanable.
- E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.6 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or Type II.
 - b. Thickness: 2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 14 inches.

2.7 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Fans: Direct drive mixed flow plenum.
- C. Motors:
 - 1. Comply with NEMA Premium designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.8 AIR FILTRATION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

B. Cleanable Filters:

1. Cleanable metal mesh.

C. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.
 - a. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.9 DAMPERS

A. Outdoor-Air and Supply-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Coupling: V-bolt and V-shaped, toothed cradle.

5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
7. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
8. Temperature Rating: Minus 22 to plus 122 deg F.

2.10 INDIRECT-FIRED GAS BURNER

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners: Stainless steel.
 1. Rated Minimum Turndown Ratio: 24 to 1.
 2. Fuel: Natural gas.
 3. Ignition: Electronically controlled electric spark with flame sensor.
 4. Gas Control Valve: Modulating.
 5. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
- D. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
- E. Heat Exchanger: Stainless steel.
- F. Heat-Exchanger Drain Pan: Stainless steel.
- G. Safety Controls:
 1. Gas Manifold: Safety switches and controls complying with ANSI standards.
 2. Vent Flow Verification: Differential pressure switch to verify open vent.
 3. High Limit: Thermal switch or fuse to stop burner.
 4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
 8. Control Transformer: 24 V ac.

2.11 UNIT CONTROL PANEL

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
- B. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:
 - 1. On-off-auto fan switch.
 - 2. Heat-vent-off switch.
 - 3. Supply-fan operation indicating light.
 - 4. Heating operation indicating light.
 - 5. Thermostat.
 - 6. Damper position potentiometer.
 - 7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
 - 8. Safety-lockout indicating light.
 - 9. Enclosure: NEMA 250, Type 4.

2.12 CONTROLS

- A. Control Devices:
 - 1. Discharge air temperature sensor.
 - 2. Outdoor air/Intake air temperature sensor.
- B. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
- C. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
- D. Temperature Control:
 - 1. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
 - 2. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

2.13 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.14 MATERIALS

- A. Steel:

1. ASTM A36/A36M for carbon structural steel.
 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
1. Manufacturer's standard grade for casing.
 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Unit Support: Install unit level on structural curbs. Secure units to structural support with anchor bolts. Coordinate sizes and locations of curbs with actual equipment provided.
- B. Install gas-fired units in accordance with NFPA 54.
- C. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
 1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.
- B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCTWORK CONNECTIONS

- A. Duct Connections: Connect supply ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Wires and Cables."
- B. Ground equipment according to Section 260526 "Grounding."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Basic Electrical Requirements."

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring according to Section 16120 "Wires and Cables."

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

3.8 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

- A. After completing system installation and testing, adjusting, and balancing makeup air unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION

SECTION 15810 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Duct materials.
 - 2. Single-wall, spiral round ducts.
 - 3. Double-wall, insulated, glass-fiber-reinforced plastic round ducts.
 - 4. Ductwork fabrication.
 - 5. Glass-fiber ductwork fabrication.
 - 6. Duct cleaning.

- B. Related Requirements:
 - 1. Section 09900 - Painting and Coating: Requirements for painting or coating as specified in this Section.
 - 2. Section 15820 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

1.02 REFERENCE STANDARDS

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE Handbook - Fundamentals.

- B. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
 - 2. AWS D1.1M - Structural Welding Code - Steel.
 - 3. AWS D1.2 - Structural Welding Code - Aluminum.
 - 4. AWS D1.2M - Structural Welding Code - Aluminum.
 - 5. AWS D9.1 - Sheet Metal Welding Code.
 - 6. AWS D9.1M - Sheet Metal Welding Code.

- C. ASTM International:
 - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A36M - Standard Specification for Carbon Structural Steel.
 - 3. ASTM A90 - Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - 4. ASTM A90M - Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - 5. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 6. ASTM A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 7. ASTM A568 - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

8. ASTM A568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
9. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
11. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
12. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
13. ASTM A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
14. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
15. ASTM A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
16. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
17. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
18. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
19. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
20. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
21. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
22. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. International Code Council:

1. International Energy Conservation Code (IECC).
2. International Mechanical Code (IMC).

E. NFPA:

1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA 016 - HVAC Air Duct Leakage Test Manual.
2. SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Guidelines.
3. SMACNA 1884 - Fibrous Glass Duct Construction Standards.
4. SMACNA 1966 - HVAC Duct Construction Standards - Metal and Flexible.

- G. UL:
 - 1. UL 181 - Factory-Made Air Ducts and Air Connectors.
 - 2. UL 181A - Closure Systems for Use With Rigid Air Ducts.
 - 3. UL 1978 - Grease Ducts.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer information for duct materials.
- C. Shop Drawings:
 - 1. Submit duct fabrication drawings, drawn to scale not smaller than 1/8 inch equals 1 foot, on sheets same size as Contract Drawings, indicating following:
 - a. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other Work.
 - b. Duct layout that further indicates pressure classifications and sizes in plan view; exhaust duct systems that further indicate classification of materials handled as specified in this Section.
 - c. Fittings.
 - d. Reinforcing details and spacing.
 - e. Seam and joint construction details.
 - f. Penetrations through fire-rated and other walls.
 - g. Hangers and supports, including methods for vibration isolation and building and duct attachment.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.
- F. Test and Evaluation Reports: Indicate pressure tests performed, including date, section tested, test pressure, and leakage rate according to SMACNA 016.
- G. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
 - 2. Submit special procedures for glass-fiber ducts.
- H. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, installer, and licensed professional.
 - 2. Submit manufacturer's approval of installer.
 - 3. Welders: Qualify procedures and personnel according to AWS D1.1 for hangers and supports, AWS D1.2 for aluminum supports, and AWS D9.1 for duct joint and seam welding.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01770 - Contract Closeout: Requirements for submittals.

- B. Project Record Documents:
 - 1. Record actual locations of ducts and duct fittings.
 - 2. Record changes in fitting location and type.
 - 3. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Perform Work according to SMACNA 1884 and 1966.
- B. Construct ductwork to, NFPA 90B, and NFPA 96 standards.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.08 AMBIENT CONDITIONS

- A. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
- B. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.09 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Section 01770 - Contract Closeout Contract Closeout: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for ducts.

PART 2 - PRODUCTS

2.01 DUCTS

- A. Performance and Design Criteria:
 - 1. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission of Architect/Engineer.
 - 2. Size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.
- B. Materials:
- C. Galvanized-Steel Ducts:
 - 1. Material: ASTM A653 galvanized-steel sheet.
 - 2. Quality: Lock forming.
 - 3. Finish: G90 zinc coating according to ASTM A90.
- D. Steel Ducts: Comply with ASTM A1008.
- E. Fasteners: Rivets, bolts, or sheet metal screws.

2.02 SINGLE-WALL, SPIRAL ROUND DUCTS

- A. Description:
 - 1. UL 181, Class 1, round spiral lockseam duct.
 - 2. Material: Galvanized steel.
- B. Duct Coating:
 - 1. Material: PVC.
 - 2. Thickness: 4 mils on outside and 1 mil on inside.
 - 3. Temperature Range: Minus 30 to plus 200 degrees F.
- C. Minimum Duct Wall Thicknesses:
 - 1. Diameter 2 to 14 Inches 26 gage. 16 to 26 Inches 24 gage. 28 to 36 Inches 22 gage. 38 to 50 Inches 20 gage. 52 to 60 Inches 18 gage.
- D. Minimum Fittings Wall Thicknesses:
 - 1. Diameter 2 to 14 Inches 24 gage. 16 to 26 Inches 22 gage. 28 to 36 Inches 20 gage. 38 to 50 Inches 20 gage. 52 to 60 Inches 18 gage.

2.03 DOUBLE-WALL, INSULATED, GLASS-FIBER-REINFORCED PLASTIC ROUND DUCTS

- A. Manufacturers:
 - a. Peabody Spunstrand.
 - b. Perry Fiberglass Products.
 - c. Viron International Corporation.
 - d. Engineered Composite Systems
 - e. An-Cor
- B. Description:
 - 1. Inner and Outer Walls: Filament-wound glass-fiber-reinforced plastic with fire-retardant thixotropic resin.
 - 2. Flame-spread index of less than 25 Smoke-developed index of less than 50 when tested according to ASTM E84.
- C. Minimum Duct and Fittings Wall Thicknesses:
 - 1. Diameter 4 to 20 Inches 0.188 inch.
 - 2. Diameter 22 to 36 Inches 0.220 inch.
- D. Insulation:
 - 1. Thermal Resistance: 5.4 sq. ft. x h x deg. F/Btu.
 - 2. Thickness: 3/4 inch.
- E. Joints: Galvanized sheet metal sleeve located inside duct, sealed and secured with screws.

2.04 FABRICATION

- A. Rectangular Ducts:
 - 1. According to SMACNA 1966 and as indicated on Drawings.
 - 2. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.
- B. Round Ducts:
 - 1. According to SMACNA 1966 and as indicated on Drawings.
 - 2. Seams: Longitudinal.
 - 3. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.
- C. Tees, Bends, and Elbows:
 - 1. Minimum Radius:
 - a. 1-1/2 times centerline duct width.
 - b. If not possible or if rectangular elbows are used, provide airfoil turning vanes.
- D. Divergence:
 - 1. Increase duct sizes gradually, not exceeding 15 degrees of divergence wherever possible.
 - 2. Upstream of Equipment: Maximum 30 degrees.
 - 3. Downstream of Equipment: Maximum 45 degrees.
- E. Welding:
 - 1. Continuously Welded Round and Oval Duct Fittings: Two gages heavier than duct gages according to SMACNA 1966.
 - 2. Cemented Slip Joints:

- a. Minimum 4 inches.
 - b. Brazed or electric welded.
- 3. Prime coat welded joints.
- F. Takeoffs:
 - 1. Provide standard 45-degree lateral wye takeoffs.
 - 2. If not possible due to space limitations, provide 90-degree conical tee connections.
- G. Sealing:
 - 1. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
 - 2. Sealants, Mastics, and Tapes: Comply with UL 181A and provide products bearing appropriate UL 181A markings.
- H. Glass-Fiber Ducts:
 - 1. Fabricate according to SMACNA 1884, except as indicated on Drawings.
 - 2. Tape: 2-inch-wide pressure-sensitive tape, according to UL 181A.
 - 3. Machine-fabricate glass-fiber ducts and fittings; only minor on-Site adjustments are permitted.
 - 4. Staples for Duct Joints and Tape:
 - a. Material: Aluminum.
 - b. Size: 3 inches wide by 2 mils thick.
 - 5. Do not use glass-fiber ducts within 12 inches of electric- or fuel-fired heaters.

2.05 ACCESSORIES

- A. Hangers and Supports:
 - 1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - 2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 3. Strap and Rod Sizes:
 - a. Comply with SMACNA 1966.
 - b. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
 - 4. Trapeze and Riser Supports:
 - a. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - b. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - c. Supports for Aluminum Ducts: Aluminum or galvanized steel, coated with zinc chromate.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01770 - Contract Closeout: Requirements for installation examination.
- B. Verify sizes of equipment connections before fabricating transitions.

3.02 PREPARATION

- A. Section 01770 - Contract Closeout: Requirements for installation preparation.
- B. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
- C. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.

3.03 INSTALLATION

- A. Install and seal ducts according to SMACNA 1966.
- B. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
- C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.
- D. Outdoor Ductwork: Protect ductwork and ductwork supports, linings, and coverings from weather.
- E. Exhaust Outlet Locations:
 - 1. Minimum Distance from Property Lines: 3 feet.
 - 2. Minimum Distance from Building Openings: 3 feet.
 - 3. Minimum Distance from Outside Air Intakes: 10 feet.
- F. Interface with Other Work:
 - 1. Install openings in ductwork as required to accommodate thermometers and controllers.
 - 2. Install pitot tube openings for testing of systems, complete with metal can with spring device or screw to prevent air leakage.
 - 3. If openings are provided in insulated ductwork, install insulation material inside metal ring.

3.04 FIELD QUALITY CONTROL

- A. Section 01770 - Contract Closeout: Requirements for testing, adjusting, and balancing.
- B. Testing:
 - 1. Ductwork Designed for 3-Inch wg above Ambient Pressure:
 - a. Pressure test minimum 25 percent of ductwork after duct cleaning but before duct insulation is applied or ductwork is concealed.
 - b. Comply with SMACNA 016.
 - c. Maximum Allowable Leakage: According to IECC.

3.05 CLEANING

- A. Section 01770 - Contract Closeout: Requirements for cleaning.

- B. Clean duct system and force air at high velocity through duct to remove accumulated dust.
- C. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.
- D. Protect sensitive equipment with temporary filters or bypass during cleaning.

3.06 ATTACHMENTS

- A. Ductwork Material Schedule:
 - 1. Supply - Heating Systems: Steel, aluminum, or fibrous glass.
 - 2. General Exhaust: Steel or aluminum.
 - 3. Outside Air Intake: Steel.
 - 4. Combustion Air: Steel.
- B. Ductwork Pressure Class Schedule:
 - 1. Constant Volume Supply: 1-inch wg, regardless of velocity.
 - 2. Supply - Heating Systems: 1/2-inch wg.
 - 3. General Exhaust: 1/2-inch wg.

END OF SECTION

SECTION 15820

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Duct access doors.
3. Volume control dampers.
4. Flexible duct connections.
5. Duct test holes.
6. Dial thermometers.
7. Static pressure gages.

B. Related Sections:

1. Section 15910 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
2. Section 15810 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
3. Section 16100 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers duct access doors and duct test holes.
- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
- D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
 - 1. Backdraft dampers.
 - 2. Flexible duct connections.
 - 3. Volume control dampers.
 - 4. Duct access doors.
 - 5. Duct test holes.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01770 – Contract Closeout: Closeout procedures.
- B. Project Record Documents: Record actual locations of access doors test holes.

1.05 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 COORDINATION

- A. Coordinate Work where appropriate with building control Work.

1.09 WARRANTY

- A. Section 01770 – Contract Closeout: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for duct accessories.

PART 2 - PRODUCTS

2.01 BACK-DRAFT DAMPERS

- A. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel, or extruded aluminum. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.02 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
 1. Less than 12 inches square, secure with sash locks.
 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 4. Larger Sizes: Furnish additional hinge.
 5. Access panels with sheet metal screw fasteners are not acceptable.

2.03 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
 4. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.
- E. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.04 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 2. Net Fabric Width: Approximately 3 inches wide.
 3. Metal: 3 inch wide, 24 gage galvanized steel.
- C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.05 DUCT TEST HOLES

- A. Furnish materials according to SMACNA standards.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.06 DIAL THERMOMETERS

- A. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

1. Size: 3 inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

2.07 STATIC PRESSURE GAGES

- A. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.
- B. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify ducts and equipment installation are ready for accessories.
- B. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.02 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15810 for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.
- C. Access Doors: Install access doors at the following locations:
 1. Spaced every 50 feet of straight duct.
 2. Upstream of each elbow.
 3. Before and after each duct mounted filter.
 4. Before and after each duct mounted coil.
 5. Before and after each duct mounted fan.
 6. Before and after each automatic control damper.
 7. Downstream of each VAV box.
 8. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.
- D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.
- E. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

3.03 INSTALLATION - THERMOMETERS

- A. Install thermometers in air duct systems on flanges.
- B. Where thermometers are provided on local panels, duct mounted thermometers are not required.
- C. Locate duct-mounted thermometers minimum 10 feet downstream of mixing-dampers, coils, or other devices causing air turbulence.
- D. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F. Install thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.04 DEMONSTRATION

- A. Section 01770 – Contract Closeout: Requirements for demonstration and training.

3.05 SCHEDULES

- A. Dial Thermometer Location:
 1. Each supply air zone.
 2. Outside air.

END OF SECTION

SECTION 15830 - HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Upblast centrifugal roof fans.
- B. Related Sections:
 - 1. Section 15505 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 - 2. Section 15525 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
 - 3. Section 15540 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
 - 4. Section 1590 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 5. Section 15810 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
 - 6. Section 15820 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 7. Section 16100 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. ASTM International:
 - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01770 - Contract Closeout: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for fans.

1.09 MAINTENANCE SERVICE

- A. Section 1770 - Contract Closeout Requirements for maintenance service.
- B. Furnish service and maintenance of fans for one years from Date of Substantial Completion.
- C. Examine each fan components bi-monthly. Clean, adjust, and lubricate equipment.
- D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing fans from service during building normal occupied hours.
- F. Provide emergency call back service during working hours for this maintenance period.
- G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- H. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.10 EXTRA MATERIALS

- A. Section 1770 - Contract Closeout: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include, but are not limited to:
 - 1. Greenheck.
 - 2. Loren Cook.
 - 3. New York Blower.
- B. Fan Unit: Upblast type. direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Totally enclosed fan cooled.

- E. Roof Curb: 16 inch high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, hinged curb adapter, and factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 4 enclosure.
- G. Accessories:
 - 1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
 - 2. Fan speed controller.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.02 INSTALLATION

- A. Secure roof fans with stainless steel lag screws to roof curb and structure.
- B. Install backdraft dampers on inlet to roof exhaust fans.
- C. Install safety screen where inlet or outlet is exposed.
- D. Install backdraft dampers on discharge of exhaust fans
- E. Provide sheaves required for final air balance.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.04 CLEANING

- A. Section 01770 – Contract Closeout: Requirements for cleaning.
- B. Vacuum clean coils and inside of fan cabinet.

3.05 DEMONSTRATION

- A. Section 01770 – Contract Closeout: Requirements for demonstration and training.
- B. Demonstrate fan operation and maintenance procedures.

3.06 PROTECTION OF FINISHED WORK

- A. Section 01770 – Contract Closeout: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 15850

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grilles.

B. Related Sections:

1. Section 09900 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
2. Section 15910 - Direct-Digital Control System for HVAC: Operators for adjustable louvers.
3. Section 15820 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

A. Section 01330 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

1.05 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for air outlets and inlets.

PART 2 - PRODUCTS

2.01 DUCT MOUNTED SUPPLY GRILLES

- A. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include, but are not limited to:
 - 1. Titus.
 - 2. Price.
 - 3. Or equal.
- B. Aluminum supply grilles shall be direct spiral duct-mounted supply grilles for the sizes and mounting types as shown on the plans and outlet schedule. The deflection blades shall be available parallel to the long or short dimension of the grille. All supply grilles shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter. All supply grilles shall be constructed with a 1 3/8-inch wide border.
- C. Blades shall be constructed of heavy duty extruded aluminum and shall be spaced 3/4-inch apart. Blades shall extend completely through the side frame on each side to ensure stability throughout the complete cfm operating range of the grille. Blades shall be individually adjustable without loosening or rattling and shall be securely held in place with tension wire.
- D. Optional air scoop damper/extractor (option ASD) shall be constructed of heavy duty aluminum. The ASD must be operable from the face with a screwdriver.

2.02 DUCT MOUNTED EXHAUST GRILLES

- A. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include, but are not limited to:
 - 1. Titus.
 - 2. Price.
 - 3. Or equal.
- B. Aluminum return grilles shall be 3/4 inch blade spacing). The fixed deflection blades shall be available parallel to the short dimension of the grille. Construction shall be of extruded aluminum with a 1 1/4-inch wide border on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Minimum border thickness shall be 0.040 to 0.050 inch. Screw holes shall be countersunk for a neat appearance.
- C. Blades shall be contoured to a specifically designed and tested cross-section to meet published performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade shall have a fixed deflection angle of 45°.

- D. Optional opposed-blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify inlet and outlet locations.

3.02 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 15820.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 15910 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes control equipment and software.
- B. Related Sections:
 - 1. Section 15930 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
 - 2. Section 16100 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.03 SYSTEM DESCRIPTION

- A. Automatic temperature controls field monitoring and control system using field programmable microprocessor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Provide controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and other equipment when directly connected to control units. Individual terminal unit control is specified in Section 15900.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- F. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.04 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate the following:
 - 1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 - 2. Connected data points, including connected control unit and input device.
 - 3. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, routers, and interconnections.
 - 5. Description and sequence of operation for operating, user, and application software.
 - 6. Use terminology in submittals conforming to ASME MC85.1.
 - 7. Coordinate submittals with information requested in Section 15930.
- C. Product Data: Submit data for each system component and software module.
- D. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01770 - Contract Closeout: Requirements for submittals.
- B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Submit data specified in "Submittals" in final "Record Documents" form.
- C. Operation and Maintenance Data:
 - 1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.07 PRE-INSTALLATION MEETINGS

- A. Section 01300 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Section 01770 - Contract Closeout: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for direct digital controls.

1.10 MAINTENANCE SERVICE

- A. Section 01770 - Contract Closeout: Requirements for maintenance service.
- B. Furnish service and maintenance of control systems for one years from Date of Substantial Completion.
- C. Furnish complete service of controls systems, including callbacks. Make minimum of 1 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls. Submit written report after each inspection.
- D. Furnish two complete inspections, one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.
- E. Examine unit components bi-monthly. Clean, adjust, and lubricate equipment.
- F. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- G. Perform work without removing units from service during building normal occupied hours.
- H. Provide emergency call back service during working hours for this maintenance period.
- I. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- J. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

- K. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

PART 2 - PRODUCTS

2.01 DIRECT DIGITAL CONTROLS

- A. Manufacturers:
 - 1. Johnson Controls.
 - 2. Rockwell Automation.
 - 3. Approved equivalent.

2.02 OPERATOR WORKSTATION

- A. Furnish each operator workstation consisting of the following:
- B. Personal Computer: IBM PC compatible with sufficient memory and hard drive storage to support graphics, reports, and communication requirements.
- C. Monitor: Minimum of 17 inch CRT.
- D. Printer: Furnish each operator workstation with laser printer and associated cables. Printer capable of minimum of 14 pages per minute (PPM) operation and compatible with standard parallel or USB communications or network capable.
- E. System Support: Minimum ten (10) work stations connected to multi-user, multi-tasking environment with concurrent capability to:
 - 1. Access DDC network.
 - 2. Access or control same control unit.
 - 3. Access or modify same control unit database.
 - 4. Archive data, alarms, and network actions to hard disk regardless of what application programs are being currently executed.
 - 5. Develop and edit database.
 - 6. Implement and tune DDC control.
 - 7. Develop graphics.
 - 8. Control facility.

2.03 PORTABLE OPERATOR'S TERMINAL

- A. Furnish device capable of accessing system data and capable of being connected to any point on system network or connected directly to any controller for programming, set-up, and troubleshooting. Portable Operators Terminal uses Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135, to communicate with BACnet objects in internetwork. Objects supported include: Analog input, analog output, analog value, binary input, binary output, binary value, device.

2.04 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both data base and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value occurring among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic Temperature Control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling.
- D. Global Communications:
 - 1. Broadcast point data onto network, making information available to other system controls units.
 - 2. Transmit input/output points onto network for use by other control units and use data from other control units.
- E. Input/output Capability:
 - 1. Discrete/digital input (contact status).
 - 2. Discrete/digital output.
 - 3. Analog input.
 - 4. Analog output.
 - 5. Pulse input (5 pulses/second minimum).
 - 6. Pulse output (0-655 seconds in duration with 0.01-second resolution minimum).
- F. Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs. Furnish control units with minimum 30 percent spare capacity.

- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice grade phone lines.
- I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
 - 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
 - 2. Control output points but change only database state or value; leave external field hardware unchanged.
 - 3. Enable control-actions on output points but change only data base state or value.
- J. Local display and adjustment panel: Portable or Integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
 - 1. Input/output point information and status.
 - 2. Controller set points.
 - 3. Controller tuning constants.
 - 4. Program execution times.
 - 5. High and low limit values.
 - 6. Limit differential.
 - 7. Set/display date and time.
 - 8. Control outputs connected to the network.
 - 9. Automatic control outputs.
 - 10. Perform control unit diagnostic testing.
- K. Points in "Test" mode.

2.05 OPERATING SYSTEM SOFTWARE

- A. Input/output Capability From Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. Command selected equipment to specified state.
 - 3. Initiate logs and reports.
 - 4. Change analog limits.
 - 5. Add, delete, or change points within each control unit or application routine.
 - 6. Change point input/output descriptors, status, alarm descriptors, and unit descriptors.
 - 7. Add new control units to system.
 - 8. Modify and set up maintenance scheduling parameters.
 - 9. Develop, modify, delete or display full range of color graphic displays.
 - 10. Automatically archive select data even when running third party software.
 - 11. Capability to sort and extract data from archived files and to generate custom reports.
 - 12. Support two printer operations.
 - 13. Alarm printer: Print alarms, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off.
 - 14. Data printer: Print reports, page prints, and data base prints.

15. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 16. Print selected control unit database.
- B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Use standard procedures for changes. Control unit automatically checks workstation data base files upon connection and verify data base match. Include the following minimum capabilities:
1. Add and delete points.
 2. Modify point parameters.
 3. Change, add, or delete English language descriptors.
 4. Add, modify, or delete alarm limits.
 5. Add, modify, or delete points in start/stop programs, trend logs, and other items.
 6. Create custom relationship between points.
 7. Create or modify DDC loops and parameters.
 8. Create or modify override parameters.
 9. Add, modify, and delete applications programs.
 10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
1. Utilizes custom symbols or system supported library of symbols.
 2. Sixteen (16) colors.
 3. Sixty (60) outputs of real-time live dynamic data for each graphic.
 4. Dynamic graphic data.
 5. 1,000 separate graphic pages.
 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- E. Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
 2. Interrogate LAN for updated point data when requested.
 3. Allow operator command of devices.
 4. Allow operator to place specific control units in or out of service.
 5. Allow parameter editing of control units.
 6. Store duplicate data base for every control unit and allow down loading while system is on line.
 7. Control or modify specific programs.
 8. Develop, store and modify dynamic color graphics.
 9. Data archiving of assigned points and support overlay graphing of this data using up to four (4) variables.
- F. Alarm Processing:
1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state or value and alarms causing automatic dial-out.
 2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
 3. Print on line changeable message, up to 60 characters in length, for each alarm point specified.

4. Display alarm reports on video. Display multiple alarms in order of occurrence.
 5. Define time delay for equipment start-up or shutdown.
 6. Allow unique routing of specific alarms.
 7. Operator specifies when alarm requires acknowledgment.
 8. Continue to indicate unacknowledged alarms after return to normal.
 9. Alarm notification:
 10. Print automatically.
 11. Display indicating alarm condition.
 12. Selectable audible alarm indication.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change of state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically start field equipment on restoration of power. Furnish time delay between individual equipment restart and time of day start/stop.
- I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 2. Compose, change, or delete message.
 3. Display or log message at any time.
 4. Assign any message to event.
- J. Reports:
1. Manually requested with time and date.
 2. Long term data archiving to hard disk.
 3. Automatic directives to download to transportable media including floppy diskettes for storage.
 4. Data selection methods to include data base search and manipulation.
 5. Data extraction with mathematical manipulation.
 6. Data reports to allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 7. Generating reports either normally at operator direction, or automatically under workstation direction.
 8. Either manually display or print reports. Automatically print reports on daily, weekly, monthly, yearly or scheduled basis.
 9. Include capability for statistical data manipulation and extraction.
 10. Capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- L. Data Collection:
1. Automatically collect and store in disk files.
 2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2-year period.

3. Daily consumption for up to 30 meters over a 2 year period.
4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
5. Archiving of stored data for use with system supplied custom reports.

M. Graphic Display: Support graphic development on work station with software features:

1. Page linking.
2. Generate, store, and retrieve library symbols.
3. Single or double height characters.
4. Sixty (60) dynamic points of data for each graphic page.
5. Pixel level resolution.
6. Animated graphics for discrete points.
7. Analog bar graphs.
8. Display real time value of each input or output line diagram fashion.

N. Maintenance Management:

1. Run time monitoring, for each point.
2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
3. Equipment safety targets.
4. Display of maintenance material and estimated labor.
5. Target point reset, for each point.

O. Advisories:

1. Summary containing status of points in locked out condition.
2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
3. Report of power failure detection, time and date.
4. Report of communication failure with operator device, field interface unit, point and programmable control unit.

2.06 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and S.I. metric units of measurement.

B. Demand Limiting:

1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
3. Forecast demand (kW): Predicted by sliding window method.
4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
5. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
7. Limits: Include control band (upper and lower limits).
8. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements and requiring operator acknowledgment.

- C. Duty Cycling:
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
 2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
 3. Set and modify following parameters for each individual load.
 - a. Minimum and maximum off time.
 - b. On/Off time in one-minute increments.
 - c. Time period from beginning of interval until cycling of load.
 - d. Manually override the DDC program and place a load in an On or Off state.
 - e. Cooling Target Temperature and Differential.
 - f. Heating Target Temperature and Differential.
 - g. Cycle off adjustment.
- D. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop/scheduling of building loads.
 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
 3. Special day's schedule supporting up to 30 unique date/duration combinations.
 4. Number of loads assigned to time program; with each load having individual time program.
 5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
 6. Furnish the following time schedule operations:
 - a. Start.
 - b. Optimized Start.
 - c. Stop.
 - d. Optimized Stop.
 - e. Cycle.
 - f. Optimized Cycle.
 7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
 8. Create temporary schedules.
 9. Broadcast temporary "special day" date and duration.
- E. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
 2. Adaptive and self-tuning, adjusting to changing conditions unattended.
 3. For each point under control, establish and modify:
 - a. Occupancy period.
 - b. Desired temperature at beginning of occupancy period.
 - c. Desired temperature at end of occupancy period.
- F. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.

2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.
- H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
 2. Output may be analog value.
 3. Provide for "skip" logic.
 4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.
- I. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
1. Control loops: Defined using "modules" are analogous to standard control devices.
 2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
 3. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Low signal selector.
 - f. Single pole double-throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
 5. Display: Value or state of each of lines interconnecting DDC modules.
- J. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
 - a. Control loop being tuned.
 - b. Input (process) variable.
 - c. Output (control) variable.
 - d. Set-point of loop.
 - e. Proportional band.
 - f. Integral (reset) Interval.
 - g. Derivative (rate) Interval.
 2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".
- K. Trend logging:
1. Each control unit capable of storing samples of control unit's data points.
 2. Update file continuously at operator assigned intervals.
 3. Automatically initiate upload requests and then stores data on hard disk.
 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 5. Co-ordinate sampling with specified on/off point- state.

6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.07 HVAC CONTROL PROGRAMS

A. General:

1. Support Inch-pounds and S.I. metric units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:

1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
6. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run-time control summary.
 - i. Request optimal run-time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run-time system normal start-times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
9. HVAC point summary:
 - a. Control system identifier and status.

- b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and status.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
 2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dewpoint/humidity point.
 - g. Add/delete return air dewpoint/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete atmospheric pressure.
 - k. Add/delete heating override switch.
 - l. Add/delete evaporative cooling switch.
 - m. Add/delete air flow rate.
 - n. Define enthalpy deadband.
 - o. Lock/unlock program.
 - p. Request control summary.
 - q. Request HVAC point summary.
 3. Control summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling cool enthalpy using outside air.
 - g. Calculated cooling cool enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

2.08 PROGRAMMING APPLICATION FEATURES

- A. Trend Point:
1. Sample points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.
 2. Output trend logs as line-graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

- B. Alarm Messages:
 1. Allow definition of minimum of 10 messages, each having minimum length of 120 characters for each individual message.
 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.
 3. Output assigned alarm with "message requiring acknowledgment".
 4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

- C. Weekly Scheduling:
 1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
 2. Program times for each day of week, for each point, with one minute resolution.
 3. Automatically generate alarm output for points not responding to command.
 4. Allow for holidays, minimum of 366 consecutive holidays.
 5. Operator commands:
 - a. System logs and summaries.
 - b. Start of stop point.
 - c. Lock or unlock control or alarm input.
 - d. Add, delete, or modify analog limits and differentials.
 - e. Adjust point operation position.
 - f. Change point operational mode.
 - g. Open or close point.
 - h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
 - i. Begin or end point totals.
 - j. Modify total values and limits.
 - k. Access or secure point.
 - l. Begin or end HVAC or load control system.
 - m. Modify load parameter.
 - n. Modify demand limiting and duty cycle targets.
 6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

- D. Interlocking:
 1. Permit events to occur, based on changing condition of one or more associated master points.
 2. Binary contact, high/low limit of analog point or computed point capable of being used as master. Master capable of monitoring or commanding multiple slaves.
 3. Operator commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.

2.09 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 16100 and the drawings.

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- B. Disconnect Switch: Factory-mount in control panel or on equipment.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify conditioned power supply is available to control units and to operator workstation.
- C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 15930.
- C. Install with 120 volts alternating current, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Install conduit and electrical wiring in accordance with Section 16100.
- E. Install electrical material and installation in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Section 01400 - Quality Requirements: Manufacturers' field services.
- B. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- C. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.

3.04 DEMONSTRATION AND TRAINING

- A. Section 01770 - Contract Closeout: Requirements for demonstration and training.
- B. Furnish basic operator training for persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 40 hours instructor time. Furnish training on site.

C. Demonstrate complete and operating system to Owner.

3.05 SCHEDULES

A. Alarm Schedule:

1. Types:

- a. A1: High Limit.
- b. A2: Low Limit.
- c. A3: Run Time.
- d. A4: Maintenance.
- e. A5: Status.
- f. A6: Override.
- g. A7: Freeze.
- h. A8: Low Pressure.

END OF SECTION

SECTION 15980

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Measurement of final operating condition of HVAC systems.
3. Sound measurement of equipment operating conditions.
4. Vibration measurement of equipment operating conditions.

B. Related Sections:

1. Section 15910 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
2. Section 15930 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.03 SUBMITTALS

A. Section 01330 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on TABB Report Forms.

- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and TABB International Quality Assurance program guarantee.
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in PDF binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01770 - Contract Closeout: Closeout procedures.
- B. Project Record Documents: Record actual locations of balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with TABB International Quality Assurance program.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.06 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.

- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. HVAC control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.

3.02 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

- A. Section 01770 - Contract Closeout: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.

- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain:
 - 1. Space temperatures within 5 degrees F.
 - 2. Minimal objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches differential static pressure between spaces.

3.06 SCHEDULES

- A. Partial list of Equipment Requiring Testing, Adjusting, and Balancing including but not limited to:
1. Fire Pumps.
 2. Plumbing Pumps.
 3. Steam Condensate Pumps.
 4. Boiler Feedwater Pumps.
 5. HVAC Pumps.
 6. Water Tube Boilers.
 7. Packaged Steel Water Tube Boilers.
 8. Packaged Steel Fire Tube Boilers.
 9. Forced Air Furnaces.
 10. Direct Fired Furnaces.
 11. Reciprocating Water Chillers.
 12. Air Cooled Water Chillers.
 13. Centrifugal Water Chillers.
 14. Absorption Water Chillers.
 15. Induced Draft Cooling Tower.
 16. Blow Through Cooling Tower.
 17. Air Cooled Refrigerant Condensers.
 18. Packaged Roof Top Heating/Cooling Units.
 19. Packaged Terminal Air Conditioning Units.
 20. Unit Air Conditioners.
 21. Computer Room Air Conditioning Units.
 22. Air Coils.
 23. Evaporative Humidifier.
 24. Sprayed Coil Dehumidifier.
 25. Terminal Heat Transfer Units.
 26. Induction Units.
 27. Unit Ventilators.
 28. Fan Coil Units.
 29. Air Handling Units.
 30. Fans.
 31. Air Filters.
 32. Air Terminal Units.
 33. Air Inlets and Outlets.
 34. Heat Exchangers.
- B. Report Forms
1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude

- j. Report date
- 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
- 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
- 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
- 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
- 6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
- 7. Combustion Test:
 - a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft

- f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input
 - k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air
 - p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output
8. Air Cooled Condenser:
- a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors
9. Chillers:
- a. Identification/number
 - b. Manufacturer
 - c. Capacity
 - d. Model number
 - e. Serial number
 - f. Evaporator entering water temperature, design and actual
 - g. Evaporator leaving water temperature, design and actual
 - h. Evaporator pressure drop, design and actual
 - i. Evaporator water flow rate, design and actual
 - j. Condenser entering water temperature, design and actual
 - k. Condenser pressure drop, design and actual
 - l. Condenser water flow rate, design and actual
10. Cooling Tower:
- a. Tower identification/number
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Rated capacity
 - f. Entering air WB temperature, specified and actual
 - g. Leaving air WB temperature, specified and actual
 - h. Ambient air DB temperature
 - i. Condenser water entering temperature
 - j. Condenser water leaving temperature
 - k. Condenser water flow rate

1. Fan RPM
11. Heat Exchanger:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Steam pressure, design and actual
 - h. Primary water entering temperature, design and actual
 - i. Primary water leaving temperature, design and actual
 - j. Primary water flow, design and actual
 - k. Primary water pressure drop, design and actual
 - l. Secondary water leaving temperature, design and actual
 - m. Secondary water leaving temperature, design and actual
 - n. Secondary water flow, design and actual
 - o. Secondary water pressure drop, design and actual
12. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual
 - l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Saturated suction temperature, design and actual
 - o. Air pressure drop, design and actual
13. Heating Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
14. Electric Duct Heater:
 - a. Manufacturer
 - b. Identification/number
 - c. Location

- d. Model number
 - e. Design kW
 - f. Number of stages
 - g. Phase, voltage, amperage
 - h. Test voltage (each phase)
 - i. Test amperage (each phase)
 - j. Air flow, specified and actual
 - k. Temperature rise, specified and actual
15. Induction Unit Data:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Design air flow
 - g. Design nozzle pressure drop
 - h. Final nozzle pressure drop
 - i. Final air flow
16. Unit Ventilator and Fan Coil Data:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Air flow, design and actual
 - g. Water flow, design and actual
 - h. Water pressure drop, design and actual
 - i. Entering water temperature, design and actual
 - j. Leaving water temperature, design and actual
 - k. Entering air temperature, design and actual
 - l. Leaving air temperature, design and actual
17. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
18. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow

- d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
19. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
20. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
21. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
22. Air Monitoring Station Data:
- a. Identification/location
 - b. System

- c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
23. Flow Measuring Station:
- a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Design Flow rate
 - h. Design pressure drop
 - i. Actual/final pressure drop
 - j. Actual/final flow rate
 - k. Station calibrated setting
24. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
25. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
26. Sound Level Report:
- a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
27. Vibration Test:
- a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end

- 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
- b. Test readings:
- 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
- c. Normally acceptable readings, velocity and acceleration
- d. Unusual conditions at time of test
- e. Vibration source (when non-complying)

END OF SECTION

SECTION 16050 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER in electronic format (PDF), one full size print, and one 11x17 print.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 01770. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.
- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor,

motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 - 1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
 - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).
- B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.

- C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.
- D. Coordinate with telephone company the communication service requirements. Furnish, install, and connect cable and terminal equipment not furnished, installed, or connected by telephone company. Furnish and install a 4-foot by 8-foot by 3/4-inch plywood backboard painted white, raceway from backboard to property line, and cross-connect base and blocks which utilize punchdown wiring methodology.
- E. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- H. Coordinate connection of electrical 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.
- I. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
- K. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- L. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
 1. Exposed Conduit: PVC externally coated rigid metal conduit and fittings.
 2. Underground Direct Buried Conduit: PVC externally coated rigid metal conduit.
 3. Underground Concrete Encased Conduit: Rigid nonmetallic conduit if the conductors are used for power; otherwise, use rigid metal conduit.
 4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.

- B. Indoors, use the following wiring materials:
1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - a. Exception: NEMA 7 or 9 areas require explosion-proof flexible conduit.
 2. Exposed Conduit: Rigid metal conduit or intermediate metal conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 4X, use rigid Schedule 40 PVC conduit.
 - 2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel conduit.
 3. Concealed Conduit: Rigid metal conduit or intermediate metal conduit unless indicated otherwise.
- C. Minimum size conduit shall be 3/4 inch unless shown otherwise.
- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.
- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit or fiberglass-reinforced conduit is used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.
- J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep

raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

- K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.
- N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits enter or leave NEMA 4X areas.
 - 3. Where required by the NEC.
- R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- S. Install device boxes at the height above the floor as follows for:
 - 1. Light switches, 4 feet.
 - 2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 - 3. Thermostats, 4'-0".
 - 4. Clock receptacles, 7'-0".

- T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- U. Position recessed outlet boxes accurately to allow for surface finish thickness.
- V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.
- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.

- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with requirements in Section 01730. In addition, the following requirements apply.
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
 - 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
 - 3. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$$\begin{aligned} R_{\min.} &= 4 (KV + 1) \text{ at } 25 \text{ degrees C winding temp.} \\ R_{\min.} &= IV + 1 \text{ at } 40 \text{ degrees C winding temp.} \end{aligned}$$

- 1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
 - 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
 - 1. Megger bus work phase-to-phase and phase-to-ground. Minimum acceptable steady-state value is 100 megohms.
 - 2. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).

3. Test current transformer circuits by applying current to secondary wiring at current transformer terminals until contactor trips.
 4. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
 5. After Work has been completed, demonstrate to OWNER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
 6. Make any specific tests required by the manufacturer's installation instructions.
- D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
1. Vacuum interior of cubicles and remove foreign material.
 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
 4. Fill motor bearings requiring oil.
 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
 6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
 7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
 8. Check exposed bolted power connections for tightness.
 9. Check operation of breakers, contactors, etc., and control and safety interlocks.
 10. Check tightness of bolted structural connections.
 11. Check leveling and alignment of enclosures.
 12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
 13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
 14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 16060 - GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.
- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Metal building frames.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
 - 12. Lighting standards.
 - 13. Landscape lighting.
 - 14. Signs.
 - 15. Exposed Metal Piping

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
 - 2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:

1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Ground Bus: 0.25 inch by 1 inch minimum copper ground bus where indicated.
4. Service Arrester: 2-pole, 1 phase, 120/240 volts, No. 14 AWG 3-wire including ground, 18-inch leads, with watertight enclosure.
5. Service Arrester: Electrical service arrester, pellet type, 120/240 volt, 1 phase, 3-wire, for exterior mounting.
6. Service Arrester: Electrical service arrester, 480 volts, 3-phase, 4-wire, for exterior mounting.
7. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 10 feet.
8. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or permanent mechanical compression type connectors.
- B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
- C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- D. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.

- H. Bond bare No. 4/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.
- I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 4/0 AWG grounding cable carried in duct bank.
- J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

3.02 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester using the 3-point fall of potential method. Testing shall be performed during normal dry weather conditions with at least 5 non-rain days elapsing prior to test. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms or less by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION

SECTION 16070 - SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products.
 - 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Racco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors, in NEMA 4 areas, or embedded in concrete shall be hot-dip galvanized. Products for use in NEMA 4X areas shall be stainless steel or equivalent.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: Steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, steel.
- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12 gauge or 0.105-inch-thick steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge.
 - b. 4-inch to 6-inch: 16-gauge.
 - c. Over 6-inch: 14-gauge.
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
1. Buried electrical line warnings.
 2. Identification labeling for cables and conductors.
 3. Operational instruction signs.
 4. Warning and caution signs.
 5. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- C. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- D. Wire/Cable Designation Tape Markers: Perma Sleeve Heat shrink or equivalent ~~Vinyl or vinyl cloth~~, self-adhesive, wraparound, cable/conductor markers with ~~pre~~-printed numbers and letter.
- E. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- F. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

- G. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- H. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- I. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- J. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct buried and in raceway.
- D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

Phase	480/277 Volts	208/120 Volts
A	Yellow	Black
B	Brown	Red
C	Orange	Blue
Neutral	Grey?	White
Ground	Green	Green

- E. Use conductors with color factory applied entire length of conductors except as follows:
 - 1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- F. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- G. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Instrument Cable.
 - 3. Multiconductor Control Cable.
 - 4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 01600.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. NEMA/ICEA Compliance: Provide components which comply with following standards:
 - 1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
- C. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- D. Network Wiring Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on perma sleeve type heat shrink labels for cables, all others to be machine printed ~~clear or opaque tape, stenciled~~ onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.
- F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least

4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.

- G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - e. CME Wire and Cable, Inc.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 4. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.
- B. Conductor Material other than hazardous or corrosive locations: Copper. Minimum size power wire shall be No. 12 AWG
 - 1. Conductor Material for hazardous or corrosive locations: Tinned Copper. Minimum size power wire shall be No. 12 AWG
- C. Insulation: Provide RHW/USE insulation for power conductors used in single- and 3-phase circuits with more than 120 volts to ground. Provide RHW/USE, XHHW, or insulation for power conductors used in single- and 3-phase circuits with 120 volts or less to ground
 - 1. Provide RHW, or XHHW insulation for grounding conductors installed in raceways.
 - 2. Provide insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 INSTRUMENT CABLE

- A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 16 or No. 18AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding

2.05 MULTICONDUCTOR CONTROL CABLE

- A. Multiconductor Control Cable: Concentrically cabled No. 14 AWG stranded copper conductors with saturated interstitial fillers; overall binder of nylon or similar material; and PVC jacket. Quantity of conductors shall be as indicated on Drawings. Provide Type 2010 individual conductor insulation unless otherwise indicated on Drawings as one of the following:
 - 1. Type ISS: 15 mils polyethylene with 5 mils nylon.
 - 2. Type 2010: 20 mils polyethylene with 10 mils PVC.
 - 3. Type 3015: 30 mils polyethylene with 15 mils PVC.

2.06 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.
 - 3. Provide plenum rated cable.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests including current meter calibration certificates shall be submitted to ENGINEER. Test reports shall include ambient temperature and humidity at time of testing. Notify ENGINEER 48 hours prior to test with schedule.
- B. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by CONTRACTOR with at least 5 years of experience in testing Network cabling systems.
 - 1. TESTING: CONTRACTOR shall test each network cable segment. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER.

2. DOCUMENTATION (Network Cable): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 - c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 3. ACCEPTANCE: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and receipt of documentation.
- C. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to ENGINEER.

END OF SECTION

SECTION 16130 - RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
1. Liquidtight flexible conduit.
 2. Rigid metal conduit.
 3. ~~Rigid nonmetallic conduit.~~
 4. PVC externally coated rigid metal conduit.
 5. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for the following products:
 - a. Wireway and fittings.
 - b. Conduit.
 - c. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:
1. Conduit:
 - a. Allied Tube.
 - b. Carlon.
 - c. General Electric Co.
 - d. ic Co.
 - e. Johns Manville.
 - f. Occidental Coatings.
 - g. Orangeburg.
 - h. Perma-Cote Industries.
 - i. Republic Steel.
 - j. Robroy Industries.

- k. Steelduct Co.
- l. Triangle Conduit.
- m. Wheatland Tube.
- n. Youngstown Sheet and Tube.
- 2. Liquidtight Conduit:
 - a. Anamet, Inc.
 - b. Carlon.
 - c. Electric-Flex.
 - d. Thomas and Betts.
- 3. Conduit Bodies:
 - a. Adalet-PLM.
 - b. American Electric.
 - c. Appleton Electric Co.
 - d. Carlon.
 - e. Crouse-Hinds Division, Cooper Industries, Inc.
 - f. Delta Industrial Products.
 - g. Killark Electric Mfg. Co.
 - h. Kraloy Products Co.
 - i. O-Z/Gedney Co.
 - j. Perma-Cote Industries.
 - k. Robroy Industries.
 - l. Spring City Electrical Mfg. Co.
- 4. Conduit Thread Paint:
 - a. CRC Chemicals, USA.
 - b. Sherwin Williams.
 - c. ZRC Chemical Products Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.
- B. PVC Externally Coated Rigid Metal Conduit and Fittings: ANSI C 80.1 and NEMA RN 1., Type 40, 40 mil nominal coating and thickness. The bond of the PVC to the substrate shall be stronger than the tensile strength of the PVC.
- C. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.03 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.

2.04 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic or 304 stainless steel covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
 - 1. Rigid Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
 - 2. PVC Externally Coated Rigid Metal Conduit: Use hot-dipped galvanized or cadmium-plated cast or malleable iron conduit bodies with threaded hubs factory PVC-coated. Field application of PVC coating to conduit bodies is not acceptable. Secure covers using PVC encapsulated or stainless steel screws.
 - ~~3. Nonmetallic Conduit: Use nonmetallic conduit bodies conforming to UL 514 B.~~
 - 4. NEMA 7 and NEMA 9 Areas: Use materials conforming to UL standards for the area.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16135 - CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
1. Outlet and device boxes.
 2. Pull and junction boxes.
 3. Terminal boxes.
 4. Floor boxes and service fittings.
 5. Bushings.
 6. Locknuts.
 7. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Cooper Wiring Devices
 - e. OZ/Gedney, General Signal Co.
 - f. Pass and Seymour, Inc.
 - g. RACO Div., Harvey Hubbell, Inc.

- h. Thomas & Betts Co.
- 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type JB, GS, or SHE.
 - b. Crouse-Hinds, Type GS or GRF.
- 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Cooper Wiring Devices
 - e. OZ/Gedney, General Signal Co.
 - f. Pass and Seymour, Inc.
 - g. RACO Div., Harvey Hubbell, Inc.
 - h. Thomas & Betts Co
- 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.
 - f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
- 6. Junction and Pull Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 7. Terminal Boxes:
 - a. AMFCO.
 - b. Boss.
 - c. Hoffman.
 - d. Keystone.
 - e. Hope.
- 8. Floor Boxes:
 - a. Arrow-Hart Div., Crouse-Hinds Co.
 - b. Harvey Hubbell, Inc.
 - c. Nelson Electric, General Signal Co.
 - d. Pyle-National Co.
 - e. Spring City Electrical Mfg. Co.
 - f. Square D Company.
- 9. Bushings, Knockout Closures, Locknuts, and Connectors:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midwest Electric, Cooper Industries, Inc.
 - g. OZ/Gedney Co., General Signal Co.
 - h. RACO Div., Harvey Hubbell, Inc.

- i. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

- A. Outlet Boxes: Suitable for the conduit system installation as follows:
 - 1. Exposed Conduit: Provide cast or malleable iron, zinc, electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.
 - a. Exception: Provide non-metallic or 304 stainless steel outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes where PVC-coated conduit is specified.
 - 2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.

- B. Device Boxes: Suitable for the conduit system as follows:
 - 1. Exposed Conduit: Provide cast or malleable iron, zinc electroplated device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.
 - a. Exception: Provide non-metallic or 304 stainless steel outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated device boxes where PVC-coated conduit is specified.
 - 2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.

- C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:
 - 1. Exposed Conduit: For pull and junction boxes 50 cubic inches and smaller, provide cast or malleable iron, zinc electroplated boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs and cast covers with neoprene gaskets. For pull and junction boxes larger than 50 cubic inches provide watertight sheet metal boxes. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide code-gauge sheet steel construction for boxes smaller than 1,000 cubic inches. Provide 0.10-inch steel construction, hot-dip galvanized after fabrication for boxes larger than 1,000 cubic inches. Secure box covers using No. 8 or larger machine screws spaced at intervals not exceeding 6 inches. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide nonmetallic or 304 stainless steel pull and junction boxes in NEMA 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes for areas where PVC conduit is used.
 - 2. Concealed Conduit: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

- D. Terminal Boxes: Provide compression lug type terminal strips in each terminal box with a minimum of 20 percent spare terminals. Provide appropriate NEMA enclosure rating for area in which terminal box is installed.
- E. Floor Boxes: Provide cast-iron rain-tight adjustable floor boxes as indicated, with threaded conduit entrance ends, and vertical adjusting rings, gaskets, brass floor plates with flush screw-on covers with ground flange and stainless steel cover screws.
- F. Floor Service Fittings: Provide factory pre-wired service units, suitable for power and communication work, with UL fire resistance rating of 3 hours. Construct integral fire-stop with cold smoke barrier to prevent passage of smoke where heat is not present. Provide units with separation barrier between power and communication compartments, and with above-floor fittings of contoured die-cast aluminum with satin chrome finish covers. Provide poke-throughs with a single divided through-floor conduit, of proper length for floor thickness indicated, and a 4-11/16-inch square by 2-9/16-inch deep junction box, which is self-supporting without attachment of above-floor fitting.
- G. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at sheet steel enclosures in NEMA 4 areas.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Receptacles.
 - 2. Ground fault circuit interrupter receptacles.
 - 3. Plugs.
 - 4. Plug connectors.
 - 5. Network outlets.
 - 6. Snap Switches
 - 7. Wall plates.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Bryant Electric Co., Division of Hubbell Corporation.
 - 2. Cooper Wiring Devices.
 - 3. Hubbell, Inc.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. Pass and Seymour, Inc.

2.02 WIRING DEVICES

- A. Provide devices which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Provide ivory color devices and wall plates except as otherwise indicated.
- B. Receptacles, Industrial Heavy-Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.
- C. Ground Fault Circuit Interrupter (GFCI) Receptacles: Provide specification grade or heavy-duty "feed-through" type ground fault circuit interrupter, with integral grounding type NEMA 5-20R

duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide units rated Class A, Group 1, per UL Standard 94.3.

- D. Network Outlets: Network outlets shall consist of box, wall plate, and RJ-45 jack. Network outlet shall comply with requirements of CAT-5E cabling systems. Wall plates shall match color and style of receptacle and switch wall plates used throughout the Project.
- E. Snap Switches: Provide Industrial Heavy-Duty Spec Grade Switches grade or heavy-duty AC switches rated 20A at 120/277 volts AC. Provide single pole, 2-pole, 3-way or 4-way switches as indicated. Comply with UL 20 and NEMA WD1.

2.03 WIRING DEVICE ACCESSORIES

- A. Wall plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Exterior receptacle covers shall provide rainproof protection while in use. Conform to requirements of Section 16075. Provide plates possessing the following additional construction features:
 1. NEMA 12 and Unclassified Areas. Material and Finish: 0.04-inch-thick stainless steel, or 0.04-inch-thick brass, chrome plated.
 2. NEMA 4 Area Material and Finish: Cast screw cap and cover plate for receptacles. Cast cover plate with lever or plunger operator for switches.
 3. NEMA 4X Material and Finish: Non-metallic or 304 stainless steel, watertight wall plates 0.05-inch-thick aluminum, anodized.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16151 - VARIABLE FREQUENCY DRIVE UNIT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete simplex type variable frequency drive (VFD) units and appurtenances including drive reactors, DC chokes, harmonic filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.
- B. Variable frequency drive unit shall be furnished, installed and electrically connected by the electrical subcontractor.
- C. VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.
- D. Provide control system operation, input and control signals, status signals and devices in accordance with Division 13.
- E. Provide Underwriter's Laboratories listed drive components where applicable.
- F. Provide VFD output filter or reactor, when cable length between VFD and motor is greater than 20 feet, to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9.
- G. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC).

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Section 16150: Electric Motors

1.03 REFERENCES:

- A. Underwriter's Laboratories Inc. (U.L.):
 - 1. UL-508 Electrical Industrial Control Equipment.
- B. National Electrical Manufacturers Association (NEMA): MG 1.
- C. IEEE 519

- D. National Fire Protection Association (NFPA):
 - 1. NFPA-70 National Electric Code.

1.04 SUBMITTALS:

- A. Shop Drawings: Submit the following in accordance with Section 01340 – Shop Drawings and Submittals:
 - 1. Shop Drawings: Provide a complete list of equipment components, and materials, including manufacturer's descriptive and technical literature, and catalog cuts. Provide complete wiring, system interconnection and schematic diagrams for the equipment and controls furnished including external interlocked and controlled components, equipment layout, time versus current curves for protective devices and any other details required to demonstrate that the system and the required external controls has been coordinated and will properly function as designed.
 - a. Provide data to verify that drives can be used for motor lead lengths up to 100 feet without output filters. Include information from the VFD manufacturer or output filter or reactor manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG-1, section 31.40.4.2, are met. For VFD's located more than a cable length of 100 feet from the motor load provide output filter or reactor at VFD.
 - b. Provide enclosure drawings and details showing all dimensions and construction details.
 - 2. Submit information relative to location and expertise of local service office and personnel.
 - 3. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural drawings.
 - 4. For informational purposes only, submit manufacturer's printed installation instructions.
 - 5. Spare Parts Data: Submit a list of spare parts for the equipment specified.
 - 6. Operating and Maintenance Instruction Manuals:
 - a. Furnish:
 - (1) Operating instruction manuals outlining step-by-step procedures required for system startup and operation.
 - (2) Manufacturer's name, model number, service manual parts list.
 - (3) Brief description of equipment and basic operating features.
 - (4) Maintenance instruction manuals outlining maintenance procedures.
 - (5) Troubleshooting guide listing possible breakdown and repairs.
 - (6) Point-to-point connection wiring diagram for the system.
 - (7) Performance Test Reports: Upon completion of installed system, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.

1.05 QUALITY ASSURANCE:

- A. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the proper installation of each type of VFD unit with the equipment supplier prior to installation.
 - 1. Services of Service Engineer, specifically trained on type of equipment specified. Man-day requirements listed exclusive of travel time.
 - a. Assist in location of devices, methods of mounting, field erection, etc.
1 man-day.
 - b. Start-up and testing.
3 man-day.
 - c. At the end of start-up service provide for a maximum of six members of the owners staff at the facility site to receive training from the startup/testing service Engineer.
1 man-day.
 - d. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls:
2 man-day.
 - e. Man-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Shipping:
 - 1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.
 - 2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
 - 3. Deliver spare parts after installation but as specified before start-up of drives. Deliver to Owner after completion of work.
- B. Storage:
 - 1. Inspect and inventory items upon delivery to site.
 - 2. Store and safeguard equipment, material and spare parts.

1.07 WARRANTY AND SERVICE:

- A. Provide in accordance with Section 01740 and as specified.
- B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months after turning the equipment over to the Owner, and in this time period include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers.
- C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.
- B. Variable Frequency Drive Units:
 - 1. Allen Bradley.
 - 2. Square D Company.
 - 3. ABB
 - 4. Danfoss
 - 5. Siemens
 - 6. Or acceptable equivalent product.
- C. VFD Input Filters and Output Filters/Reactors:
 - 1. Trans-Coil, Inc.
 - 2. MTE Corporation.
 - 3. Power Quality International.
 - 4. Or acceptable equivalent product.

2.02 PROVISIONS:

- A. Service Conditions:
 - 1. Ambient Temperature Range: 0 deg. C to 40 deg. C.
 - 2. Operational Humidity: Up to 90 percent non-condensing.
 - 3. Environment: Enclosure NEMA 12 minimum or as designated elsewhere on drawings.
 - 4. Altitude: Below 3,300 ft. above sea level.
 - 5. Input Power:
 - a. Nominal voltage - 460 volts (plus 10 percent or minus 10 percent), 3-phase, 3 wire
 - b. Nominal Frequency - 60 Hertz (plus or minus 2 Hz.)
 - c. Service provided from feeder breaker on distribution bus.
- B. Drive System: 0-500 HP Units
 - 1. General:
 - a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to

- 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.
- b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire “start-stop” and the Contractor shall furnish wiring accordingly.
 - c. Variable frequency drive manufacturer 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 loads, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.
 - d. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.
 - e. Provide flux vector control type drives, also known as field-oriented control, with hard-wired motor speed feedback encoder or tachometer, for full torque at zero speed capability.
 - f. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2% or better and torque response time less than 20 ms.
 - g. Provide on drive, a disconnecting device and fixed diode input rectifier (for a constant power factor).
 - h. For units rated 50 Hp or less, provide 6 pulse drives with 3% impedance input line reactor.
 - i. For units rated greater than 75 Hp, provide VFD with the following type three phase PWM rectifier section: 18-pulse.
 - (1) The design shall be optimized for harmonic rich and high neutral current environment.
 - j. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15% above rated full load.
 - k. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.
 - l. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.
 - m. NEMA type cabinet for each drive unit, as indicated on drawings and enclosure schedule. NEMA 4 and NEMA 4X enclosures to be provided with stainless steel hand operated quick disconnect devices. Provide hinged acrylic door with gasketing on front of door for each access to keypad controls.

- n. For inverter rated squirrel cage motors, per NEMA Standard MG-1, part 31.40.4.2, the following limit values at the motor terminals are to be observed:
 - (1) For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.
 - o. The VFD manufacturer shall guarantee that the above voltage limits will be met with the motor installed up to 100 cable feet [30 m] from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, provide a drive output filter or reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure that the limitations listed above are maintained. A device located at the motor terminals is not acceptable.
 - p. The drive unit shall be of modular design to provide for ease and speed of maintenance.
 - q. Drive electronics to be conformal coated.
 - r. Control circuits shall be isolated from power circuits. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted manual speed potentiometer or micro-processor type keypad with unit in local mode. The input 4-20 mA signal to be optically isolated from the drive run control circuit. Manual speed potentiometer or keypad controls to have adjustable minimum speed setting of 10 to 80% of full speed and maximum speed setting of 50 to 100% of full speed. The total speed setting to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.
 - s. Provide trap filters for the drive unit to meet the requirements of the harmonic study under paragraph 2.02. Filters shall be provided with contractors and controlled by the VFD to remove them from the line when the drive is not operating. Contractors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.
 - t. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10%.
 - u. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
 - v. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions. Provide NEMA enclosure type as specified on drawings. Provide integral fans or cooling systems as required by the application. NEMA 4 and 4X type enclosures to use hand-operated locking devices for door closing hardware. Circuit breaker interlocks to be able to be bypassed via lever on front door surface. NEMA 1 type enclosures to have keypad controls located on exterior of enclosure. Provide visual alarm indicator on cabinet door.
2. Performance characteristics:
- a. Output amps: 110 percent of rated, continuous.
 - b. Current limit: Range 0 to 130% for constant torque applications, 0 to 110% for variable torque applications, for 1 minute minimum.
 - c. Acceleration time to top speed, 1-300 seconds, minimum, adjustable.

- d. Deceleration time from top speed, 1-300 seconds, minimum, adjustable.
 - e. Frequency stability: +/- 0.5% (at 25 degrees C, +/-10 degrees C) after reaching operating temperature.
 - f. Output voltage: Proportional to frequency with low speed boost.
 - g. Combined drive/and filtering efficiency, defined as motor shaft KW divided by VFD input KW, shall meet the following minimum requirements at the specified operating points:
 - (1) 97 percent at 60 Hz VFD output and 100 percent load.
 - (2) 92 percent at 50 Hz VFD output and 60 percent load.
 - h. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.
 - i. The VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.
 - j. Losses to be utilized in drive system efficiency calculation shall include the input isolation transformer, harmonic filter and power factor correction if applicable. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.
3. Drive Protection:
- a. General :
 - (1) Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature. The VFD shall employ three (3) current limit circuits to provide trip free operation. The slow current regulation limit circuit shall be adjustable to a minimum 125% of the VFD's variable torque current rating. The rapid current regulation limit shall be adjustable to a minimum 170% of the VFD's variable torque current rating. The current switch off limit shall be fixed at a minimum 225% of the VFD's variable torque current rating.
 - b. Internal Protection: Minimum circuitry as follows:
 - (1) Current limiting, fast acting, semiconductor input fuses for protection of internal power semiconductors.
 - (2) Instantaneous output overcurrent trip max. - 200 percent.
 - (3) DC bus and control circuit transformer fusing.
 - (4) Grounded control chassis.
 - (5) Under and over voltage trip, 3 phases.
 - (6) Motor overload protection, with solid state relays.
 - (7) Fault reset push button.
 - (8) Line to ground faults.
 - (9) Input metal oxide varistor and input line reactor for transient protection.
 - (10) VFD overtemperature.
 - c. Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote indication of alarms to include the following:
 - (1) Over/under voltage indication.
 - (2) Overcurrent trip indication.

- (3) DC bus charged indication.
 - (4) Fault detection indication.
 - (5) Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed).
 - d. Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting.
 - e. Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.
 - f. For drives units rated 200 hp or more, provide uninterruptable power supply (UPS) to power control circuits and prevent inadvertent trip due to voltage sag conditions. The UPS shall be installed within the drive enclosure. The battery backup time of the UPS shall be a minimum of 5 minutes or as recommended by the VFD manufacturer.
- C. Auxiliary Systems:
- 1. Provide variable frequency drive unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:
 - a. Space heaters
 - b. Solenoid valves
 - c. Remote indication of motor start and stop (isolated contacts)
- D. Minimum Control Features:
- 1. LOCAL-REMOTE selection of Start/Stop control.
 - 2. LOCAL/REMOTE selection of Speed Control.
 - 3. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.
 - 4. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.
 - 5. Digital Input/Output field adjustable parameters.
 - 6. Provide Ethernet TCP/IP communication module
- E. Devices:
- 1. Provide operating, monitoring or alarm indicating devices, on keypad, with minimum as follows:
 - a. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run).
 - b. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer).
 - c. Keypad controls to set speed in manual mode.
 - d. Speed indicating meter in percent speed to indicate speed of the converter powered motor.
 - e. Run time meter.

f. Alarm and status lights.

2.03 SHOP TESTING (18 pulse units only):

- A. Provide a factory performance test for each variable frequency drive unit. The test to consist of simulating the expected load to be driven. The drive to operate the actual motor load through the expected speed ranges. Test length to be a minimum of two hours.
- B. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
- C. Provide typical prototype factory test data for short circuit testing of each type of drive supplied. Data to verify that each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B & C) to be included in test data.
- D. Provide certified documentation of all tests performed.
- E. Provide above stated tests in addition to routine factory tests.
- F. Owner to have option to witness all factory tests. Notify Owner two weeks before all tests.

2.01 SPARE PARTS:

- A. Provide in accordance with Section 01730 and as specified.
- B. Provide one spare board or card, three diodes, for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart such that improper installation of spare cards is impossible. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one keypad for every three VFD of the same model.

PART 3 – EXECUTION

3.01 INSPECTION:

- A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.
- B. Visually inspect delivered unit(s) and accessories for conformance with specification and drawings.

- C. Verify availability of appropriate pacing signal.
- D. Maintain variable frequency drive in upright position at all times.
- E. Protect variable frequency drive against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION:

- A. Erect, install, and start-up equipment.
- B. The VFD's shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- C. Install VFD's to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.
- D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS:

- A. Three foot wide rubber mats shall be furnished and installed on the floor and in front of each VFD assembly. The mats shall be long enough to cover the full length of each VFD system. The mats shall be 1/2 inch thick with beveled edges, canvas back, solid type with corrugations running the long way, and shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mats shall meet the requirements of ASTM D 178 for Type II, Class 4 insulating matting.

3.04 FIELD TESTING:

- A. Provide in accordance with Section 01650.—section missing
- B. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of manufacturer's service engineer. Under no circumstances energize any portion of the drive system without authorization from manufacturer's technical representative.
- C. Field Tests:
 - 1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive,

motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:

- a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.
 - b. Output to the driven load in kilowatts.
 - c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.
 - d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.
2. Test each drive by using the actual control signal for remote and local operation.
 3. Test each driver's alarm functions.
 4. Perform all tests in the presence of the Owner's representative.
 5. Perform the above test in addition to the manufacturer's normal field tests.
 6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16220 - MOTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section applies, in general, to all electric or DC motor-driven equipment provided under Divisions 2 through 16 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
 - 2. Submit product literature for each motor.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment, and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label, shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:
 - 1. Motors:
 - a. Marathon Blue Chip Series.
 - b. Siemens, Inc.
 - c. General Electric Co.
 - d. Reliance Electric Co.
 - e. U.S. Electric Motors.
- B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

2.02 MATERIALS

- A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.
- B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

- A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1-1993, Rev. 1, Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
 - 1. The motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.0 or 1.15 service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
 - 2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
 - 3. The motors shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seconds.
- B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).
- C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.
- D. Multispeed motors are to be supplied with separate windings for each speed. The cost to change starters for motors supplied with reconnectable windings will be the responsibility of equipment (motor) supplier and must be coordinated with ENGINEER.
- E. All explosion-proof motors shall meet NEC Class 1, Division I, Group D, requirements with T2A temperature rating.
- F. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:
 - 1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.
 - 2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be suitable for use on 208 volt power systems under their given load conditions. They shall have

bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.

3. From 2 to 200 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard open drip-proof specifications as a vertical motor when called for or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s).
- G. Horizontal and vertical motors may also be weather protected, Type I, and shall have encapsulated or sealed windings.
- H. Open drip-proof type motors shall have encapsulated or sealed windings when called for on Drawings or Equipment Schedules.
- I. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.
- J. Motors above 200 Horsepower: Motors shall be of special design as detailed in specific sections of the Specifications. All special purpose motors, such as wound-rotor, multi-speed, variable speed, etc., shall be as detailed in specific Sections of the Specifications.
- K. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:
 1. TE Totally Enclosed, may be nonventilated, fan-cooled or air-over type.
 2. TENV Totally Enclosed Nonventilated.
 3. TEFC Totally Enclosed Fan-cooled.
 4. TEEP Totally Enclosed Explosion-proof, Class I, Div. I, Group D.
 5. ODP Open Drip-proof.
 6. WPI Weather Protected Type I.
 7. E/S Encapsulated or Sealed Windings.
 - a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.
- L. See NEMA Standard MG1 for definition of above terms.
- M. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

2.04 FABRICATION

- A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's written installation and alignment instructions.
- B. Lubricate oil-lubricated bearings.
- C. Provide electrical wiring and connections as specified in Division 16 Sections.

3.02 FIELD QUALITY CONTROL

- A. Inspect all terminations for proper connection.
- B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

- A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600 certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by any connection or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER; and
 - 5. That OWNER's representative has been instructed in the proper maintenance and operation of the equipment.
 - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

HIGH EFFICIENCY MOTOR SCHEDULE NO. 16220.2
MOTOR OPERATING CHARACTERISTICS

HP	RPM Syn.	Efficiency (percent)						
		Guar. Min.			Nominal		Power Factor (percent)	
		Full	1/2	3/4	Full	1/2	3/4	Full
1	1800	81.5	78.1	81.0	81.5	54.2	67.3	75.8
	1200	75.5	69.5	75.6	78.5	38.4	49.4	58.3
	3600	78.5	78.4	80.2	81.5	75.3	84.4	88.8
1.5	1800	81.5	79.2	82.9	84.0	52.1	65.1	74.0
	1200	81.5	80.5	83.4	84.0	44.0	56.6	85.6
	3600	81.5	78.8	82.9	84.0	66.3	78.4	85.0
2	1800	81.5	78.8	82.6	84.0	48.9	61.7	70.0
	1200	84.0	83.0	83.6	86.5	46.6	59.6	68.0
	3600	84.0	75.4	84.3	86.5	69.7	80.0	85.6
3	1800	86.5	86.9	88.5	88.5	62.3	73.9	79.9
	1200	86.5	84.5	87.5	88.5	45.9	58.3	68.0
	3600	86.5	86.2	88.2	88.5	71.7	81.7	86.4
5	1800	88.5	84.0	88.2	88.5	68.5	79.2	84.6
	1200	86.5	85.8	88.2	88.5	50.8	63.8	71.9
	3600	86.5	82.9	86.7	88.5	75.9	84.3	88.1
7.5	1800	88.5	89.2	90.3	90.2	66.5	77.2	82.4
	1200	86.5	87.5	88.8	88.5	58.6	68.8	73.7
	3600	86.5	87.7	89.0	88.5	77.1	84.5	87.6
10	1800	88.5	89.3	90.4	90.2	67.6	77.4	81.9
	1200	88.5	89.0	90.3	90.2	60.1	70.2	74.9
	3600	88.5	82.3	87.4	90.2	81.1	87.2	90.4
15	1800	90.2	91.0	91.9	91.7	68.5	78.1	82.3
	1200	88.5	89.9	90.6	90.2	67.4	77.1	81.4
	3600	90.2	89.1	91.1	91.7	83.7	88.5	90.5
20	1800	90.2	90.9	91.9	91.7	68.9	78.1	81.8
	1200	90.2	91.0	91.0	91.7	69.8	78.5	81.9
	3600	90.2	91.6	92.0	91.7	81.9	88.6	90.6
25	1800	91.7	92.8	93.2	92.4	72.7	81.4	84.5
	1200	90.2	90.0	91.4	91.7	79.8	84.5	85.5
	3600	90.2	90.6	91.7	91.7	81.1	87.8	90.3
30	1800	91.7	92.8	93.3	93.0	71.5	80.6	84.2
	1200	90.2	91.7	92.0	91.7	78.9	85.4	86.8
	3600	90.2	89.1	91.2	91.7	83.8	88.6	89.9
40	1800	91.7	91.0	92.6	93.0	71.6	80.6	84.2
	1200	91.7	93.0	93.3	93.0	80.9	86.4	88.0
	3600	90.2	88.7	90.8	91.7	82.5	90.8	92.0
50	1800	93.0	92.4	93.7	94.1	76.4	83.7	86.3
	1200	91.7	93.0	93.3	93.0	80.9	87.3	88.9
	3600	91.7	89.9	92.0	93.0	84.9	89.9	91.6
60	1800	93.0	93.2	94.0	94.1	76.3	84.0	86.8
	1200	91.7	92.5	93.1	93.0	75.8	82.9	85.5
	3600	93.0	91.0	93.1	94.1	82.6	88.7	90.9
75	1800	93.0	92.6	93.8	94.1	76.4	83.8	86.6
	1200	93.0	93.5	94.2	94.1	75.1	82.4	84.7
	3600	93.0	91.3	93.3	94.1	86.1	89.7	91.0
100	1800	94.1	93.8	94.8	95.0	83.8	87.6	89.0
	1200	93.0	93.1	93.9	94.1	72.5	80.0	83.2
	3600	93.0	91.2	93.1	94.1	83.0	88.3	89.0
125	1800	93.7	93.5	94.6	95.0	79.2	84.6	86.0
	1200	93.0	93.5	94.2	94.1	75.2	82.3	85.2
	3600	93.0	91.8	93.4	94.1	85.3	89.3	89.1
150	1800	94.1	93.7	94.7	95.0	81.6	86.4	86.6
	1200	94.1	94.1	94.9	95.0	77.2	84.4	85.7
	3600	94.1	92.7	94.3	95.0	83.3	87.5	88.5
200	1800	94.5	94.2	94.9	95.0	80.0	85.6	86.7
	1200	94.3	94.2	94.9	95.0	78.0	84.5	86.0
	3600	94.3	94.8	95.5	95.3	83.0	87.5	88.5
250	1800	94.3	96.0	96.0	95.8	79.5	85.6	83.0

END OF SECTION

SECTION 16270 - TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of transformers specified, and include the following:
1. Dry-type transformers (~~lighting transformers~~).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
 2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
 3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
 2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Acme Electric Corporation.
 2. Cutler-Hammer.
 3. General Electric Company.
 4. Hevi-Duty Electric Div., General Signal Corp.
 5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Dry-Type Distribution Transformers (45 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated

capacities indicated, single phase, 60 hertz, 10 kV BIL, 4.0 percent impedance, with 480 volts primary and 240/120 volts secondary; or K-rated 13 three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220 degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

- C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16410 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01600 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Appleton.
 - 3. Crouse-Hinds Co.
 - 4. Furnas Electric Co.
 - 5. General Electric Co.
 - 6. Siemens, Inc.
 - 7. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."
- B. Fusible Switches: (Heavy-duty) switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- C. Circuit Breaker Switches: Where individual circuit breakers are required for loads exceeding 200 Amps, provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make,

quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with AL/CU-rated mechanical screw type removable connector lugs. Where individual circuit breakers are required for loads below 200 Amps, provide bolt on circuit breakers with appropriate short circuit and trip ratings in accordance with NFPA 70 and NFPA 70E.

- D. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.
- E. Switches for Classified (Hazardous) Locations: Heavy-duty switches with UL labels and listings for hazardous location classifications in which installed.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel for NEMA 4 switches.
 - 2. Molded fiberglass-reinforced plastic or 304 stainless for NEMA 4X switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16420 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of motor controllers, including:
1. Combination controllers.
 2. Fractional HP manual controllers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and sizes.
 2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
 3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
 2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Allen-Bradley Co.
 2. Crouse-Hinds Co.
 3. Cutler-Hammer Products/Eaton Corp.
 4. ~~Emotron.~~
 5. ~~Furnas Electric Co.~~
 6. General Electric Co.
 7. Siemens, Inc.
 8. Square D Company.
 9. Veris Industries

2.02 MOTOR CONTROLLERS

- A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation.

- B. Combination Controllers: Consist of controller and circuit breaker or fusible disconnect switch mounted in common enclosure of types, sizes, ratings, and NEMA sizes indicated. Equip starters with block-type manual reset overload relays. Provide control and pilot devices indicated. Provide 90 degree C SIS or MTW, No. 14 AWG control wiring, tagged at each termination. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with 3 padlocks. Construct and mount controllers and disconnect switches in single NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.
1. The 3-phase starter may be the following types:
 - a. Full Voltage Non-reversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
 - b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
 - c. Two-speed (for two winding motor): Two, 3-pole magnetic contactors, each with its own set of 3 overload devices.
 - d. Two-speed (for single winding motor): Two magnetic contactors, a 5-pole for high speed, and a 3-pole for low speed, each with its own set of 3 overload devices.
 - e. Reduced Voltage (for wye-connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current, and starting (half-winding) contactor shall be sized for at least 75 percent of the full load current and shall be capable of interrupting at least 10 times full load current.
 - f. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay and an autotransformer with taps at 50, 65, 80, and 100 percent, and an integral temperature switch or timing relay to protect transformer windings.
- C. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in the transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of the unit requirements or provide 150VA rated transformer, whichever is greater. Provide 300 volt rated, oiltight type pilot lights, push buttons with extended guard and black color insert. Equip stop push buttons with half guard and red color insert. Provide 120/6 volt transformer type push-to-test pilot lights with lens color indicated. Provide machine tool type relays, each with 1 spare N.O. contact. Provide 6-digit elapsed time indicators with one-tenth hour increments. When timers are required, they shall be synchronous type.
- D. Fractional HP Manual Controllers: Provide 3-phase and single-phase fractional horsepower manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms, and with one-piece melting alloy type thermal units. Controller shall become inoperative when thermal unit is removed. Provide controllers with double-break silver alloy contacts, visible from both sides of controller, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16421 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's technical product data on NEMA Class 2, Type B motor control centers (MCCs).
 - 2. Submit layout Drawings of MCCs showing accurately scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.
 - 3. Fuse and Overload Sizes: Submit a compiled list of motors, fuse sizes, overload sizes, and types for motors actually installed.

- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include data and parts list for each MCC and troubleshooting maintenance guide.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with NEMA Standards Pub/No. ICS-2, pertaining to construction, testing, and installation of MCCs, and with applicable NEMA standards for circuit breakers and fuses.
 - 2. UL Compliance: Comply with applicable requirements of UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Standard 845, "Electric Motor Control Centers." Provide MCCs and ancillary equipment which are UL listed and labeled.
 - 3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to construction and installation of MCCs.
 - 4. ANSI Compliance: Comply with applicable requirements of ANSI as applicable to MCCs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley Co.
 - 2. Eaton Corporation
 - ~~3. Furnas Electric Co.-~~
 - 4. Siemens, Inc.
 - 5. Square D Company.

2.02 MOTOR CONTROL CENTERS AND COMPONENTS

- A. Provide MCCs and ancillary components of sizes, ratings, classes, types, and characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information and as required for complete installation and as specified herein.
- B. MCCs: For operation on power source rating indicated, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units, disconnects, and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Provide MCC with NEMA Class 2, Type B wiring, wire units using 90°C SIS or MTW stranded copper wire; No. 14 AWG minimum. Tag all wires at each termination.
- C. MCC Supporting Structures: Factory assembled, dead-front, MCC standard supporting structures with enclosed vertical sections, fastened together to form rigid freestanding assembly. Construct each section 90 inches high with 9-inch horizontal wireways at top and bottom, 20 inches wide, and with 20-inch section depth for front-of-board unit arrangement. Provide NEMA Type 1A enclosure. Provide gasketing on all enclosing sheet steel, wireways, and unit doors. Construct units with 4-5/8-inch wide, 8-inch deep, 90-inch high vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide front-accessible main lug compartment for connection of incoming cables in top or bottom as indicated. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable; provide holes for bolting MCC units to floor.
 1. Provide shipping splits in MCC lineup to allow for shipment of maximum 60-inch-long units. Design MCCs so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.
- D. Bus System: Tin-plated aluminum or copper, braced to withstand faults of 65,000 rms symmetrical amperes minimum unless indicated otherwise. Provide main horizontal bus with rating shown, and vertical bus rating of 300 amperes minimum; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Vertical bus shall be full length.
 1. Provide 0.25-inch by 1-inch minimum copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish 1 lug per starter unit, minimum.
- E. Starter Units: Draw-out type, magnetic motor starters with fusible switch or motor circuit protector type disconnects, auxiliary control devices, and NEMA size as indicated. Construct each starter unit with doors, unit support pans, saddles, and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Equip with thermal and magnetic overload protection device for each motor circuit, unit-mounted pilot devices, timers, selector switches, indicating lights, and control relays. Provide 1 spare normally open auxiliary contact. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other.

1. Three-phase starter may be following types:
 - a. Full Voltage Nonreversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
 - b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
 - c. Two-speed (for two-winding motor): Two 3-pole magnetic contactors, each with its own set of 3 overload devices.
 - d. Two-speed (for single winding motor): Two magnetic contactors, a 5-pole for high speed, and a 3-pole for low speed, each with its own set of 3 overload devices.
 - e. Reduced Voltage (for wye connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current and starting (half winding) contactor shall be sized for at least 75 percent of full load current and shall be capable of interrupting at least 10 times full load current.
 - f. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay, and an auto-transformer with taps at 50, 65, 80, and 100 percent and an integral temperature switch or timing relay to protect transformer windings.

- F. Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low-resistance connections.

- G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.

- H. Unit Doors: Securely mounted with rugged concealed-type hinges which allow doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.
 1. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.

- I. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of unit requirements or provide 150VA rated transformer, whichever is greater.
 1. Provide synchronous type timers unless otherwise noted.
 2. Provide 300 volt-rated, oil-tight type pilot lights, push buttons, and selector switches. Equip Start push button with extended guard and black color insert. Equip Stop push buttons with half guard and red color insert.
 3. Provide 120/6 volt transformer type push button to test pilot lights with lens color indicated.
 4. Provide machine tool type relays, each with 1 spare N.O. contact.
 5. Provide 6-digit elapsed time indicators with 1/10 hour increments.

- J. Fusible Switch: Quick-make quick-break, gang-operated switches with positive pressure fuse clips suitable for use with class of fuses required. Provide switches with continuous current rating indicated and with a 100,000 ampere interrupting capability at rated voltage.

- K. Motor Circuit Protector: Adjustable trip magnetic-only instantaneous molded-case circuit breakers for use in starter units. Provide a continuous current rating of at least 125 percent of the motor full

load current and an interrupting capacity of 65,000 amps symmetrical. Provide a field adjustable instantaneous trip unit capable of being adjusted from 7 to 13 times motor full load current.

- L. Circuit Breakers: Factory assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole and with fault-current limiting protection; ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees. Provide with AL/CU rated mechanical screw type removable connector lugs.
- M. Power Monitor: Microprocessor-based device capable of measuring each phase current, line-to-line voltage, line-to-neutral voltage, watts, VARS, power factor, demand watts, and frequency. Unit shall contain kilowatt hour totalizer. 3-CT's and 3 (fused)-PT's shall be provided and factory installed as required. Unit shall have two Form C, 2-amp rated output contacts, one to alarm upon abnormal voltage level and one to alarm on power failure.
- N. Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide 2 finish coats of manufacturer's standard color baked-on enamel finish.
- O. Spare Units: In each motor control center, provide a spare Size 2 full voltage, nonreversing combination starter. Provide a Hand-Off Auto switch and red "running" pilot light in this unit.
 - 1. In each motor control center, provide a spare 60 amp fusible switch.
 - 2. In each motor control center, provide spaces for addition of a Size 2 motor starter and a 60 amp fused feeder switch.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16440 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. Power distribution panelboards.
 2. Lighting panelboards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
 2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
 3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Eaton Corporation.
 2. General Electric Company.
 3. Siemens, Inc.
 4. Square D Company.

2.02 PANELBOARDS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 50,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide as indicated, either molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped, or bolt-on fusible switches for main and branch circuits. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Provide integrated or external Surge Protection, installed per manufacturers listing.
- C. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated. . Provide integrated or external Surge Protection, installed per manufacturers listing.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.
- E. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- F. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles where specified. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.
- G. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.

- H. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. Type out panelboard's circuit directory card upon completion of installation Work.
- B. Label all Lighting Panelboards and Distribution Panelboards in accordance with Specification 260553

END OF SECTION

SECTION 16497 - FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of fuses specified, including:
1. Class J Fuses.
 2. Class RK1 time-delay.
 3. Class RK5.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties, and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristics curves, and mounting requirements.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
1. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting Capacity Class K Fuses." Provide overcurrent protective devices which are UL listed and labeled.
 2. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering fusible devices which may be incorporated in Work include:
1. [Bussmann](#) Division, Cooper Industries.
 2. Commercial Enclosed Fuse Co.
 3. Littelfuse, Inc.
 4. Shawmut Division, Gould, Inc.
 5. Reliance Fuse Division, Federal Pacific Electric Co.

2.02 FUSES

- A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard

design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

- B. Class J Time-Delay Fuses: UL Class J time-delay fuses rated 600 volts, 60 Hertz, 800 amperes, with 200,000 rms symmetrical interrupting current rating for protecting transformers, motors, circuit breakers.
- C. Class RK1 Time-Delay Fuses: UL Class RK1 dual element time-delay fuses rated 600 volts, 60 Hertz, 400 amperes, with 200,000 rms symmetrical interrupting current rating for protecting motors and circuit breakers.

2.03 EXTRA MATERIAL

- A. Spare Fuses: For the types and ratings required, furnish additional fuses, amounting to 1 unit for every 10 installed units, but not less than 1 set of 3 of each kind.

PART 3 - EXECUTION

NOT USED

END OF SECTION

APPENDIX
OWNER FURNISHED EQUIPMENT
HUBER Q PRESS SUBMITTAL

Equipment & Controls Submittal

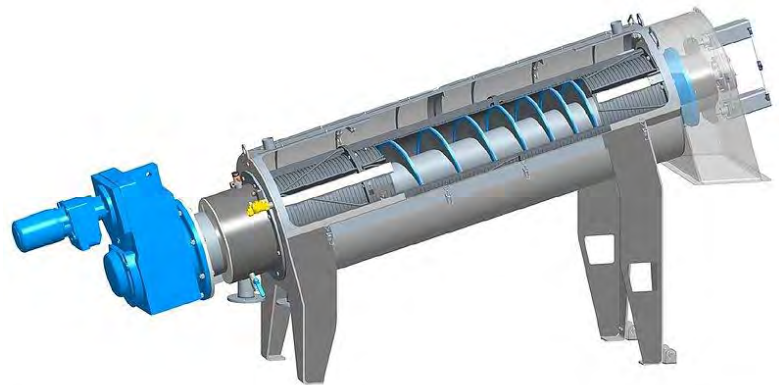
Mt. Clemens, MI

Q-PRESS 800.2

Project: 73010851

Date: 12/4/2023

Revision: 00



Submittal Content:

- Two (2) Huber Screw Press Q-PRESS 800.2 (316L)
- Two (2) Velodyne Polymer Systems
- Five (5) Ro8T Conveyors
- Q-PRESS and Conveyors Elemech Control Panels
- Ancillary Equipment

Project Manager: Julia Hahn julia.hahn@hhusa.net

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APPENDIX C:	Controls Data Sheets <ul style="list-style-type: none">- Electrical Components from Elemech- Conveyor and Q-PRESS Panels
APPENDIX D:	Operating Instructions
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APPENDIX I:	Long Term Storage

SECTION 1
REVISION HISTORY

Project: Mt. Clemens, MI	Project #: 73010851
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Submittal Revision History

Rev	Date	Changes	By
0	12/4/2023	Initial submission to City of Mt. Clemens.	JH
	Date		
	Date		
	Date		
	Date		
	Date		
	Date		
	Date		
	Date		
	Date		

SECTION 2
OPEN ISSUES/SCOPE CLARIFICATION



Project: 73010851 - Mt. Clemens, MI

Product: Q-PRESS 800.2

Open Issue Deck (OID)

#	Priority	Status	Owner	Type	Date Created	Days Open	Date Closed	Title	Action	Notes
1	Normal	Pending	ALL	Approval	12/04/23	0		Submittal Comments	n/a	Submittal package sent to City of Mt. Clemens.
3	Low	Select	Select	Select					n/a	
4	Select	Select	Select	Select					n/a	
5	Select	Select	Select	Select					n/a	
6	Select	Select	Select	Select					n/a	
7	Select	Select	Select	Select					n/a	
8	Select	Select	Select	Select					n/a	
9	Select	Select	Select	Select					n/a	
10	Select	Select	Select	Select					n/a	
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14	Select	Select	Select	Select					n/a	
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42	Select	Select	Select	Select					n/a	
43	Select	Select	Select	Select					n/a	
44	Select	Select	Select	Select					n/a	
45	Select	Select	Select	Select					n/a	
46	Select	Select	Select	Select					n/a	
47	Select	Select	Select	Select					n/a	

SECTION 3
KEY CONTACTS

PRIMARY POINT OF CONTACT

Project Management

HUBER Technology Project Manager

Julia Hahn
PH: 704.990.2443 (Julia)
julia.hahn@hhusa.net

Sales

HUBER Technology Regional Sales Director

Steve Frank - Southeast
PH: 704.330.9378 (Steve)
steve.frank@hhusa.net

Distributor

Hesco

Glenn Hummel
PH: 586-978-7200
glenn@hesco-mi.com

ADDITIONAL HUBER CONTACTS

Project Management

HUBER Technology Project Coordinator

Alyssa Gonzalez
PH: 704-949-1010
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HUBER Technology Director of Project Mgmt.

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Sales

HUBER Technology Director of Sales

Simon Randle
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Contract Administration

HUBER Technology Contract Administrator

Josey Chan
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josey.chan@hhusa.net

Service and Aftermarket

HUBER Technology Service Manager

Christian Reyer
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christian.reyer@hhusa.net

HUBER Technology Technical Support Manager

Patrick Sheehan
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patrick.sheehan@hhusa.net

SECTION 4
SCOPE OF SUPPLY

SCOPE OF SUPPLY



Mount Clemens, MI

Equipment:

HUBER Screw Press Q-PRESS 800.2®

Represented by:

Hesco
Glenn Hummel
(586) 978-7200
glenn@hesco-mi.com

Regional Sales Director:

Steve Frank
704-330-9378
Steve.Frank@hhusa.net

Project Number: 484746
Revision: 0
Date: 8/14/2023

Design Information

Technical Data		
Upstream Screening	Unknown Upstream Screening	
Sludge Type	Waste Activated Sludge	
Upstream Biological Process	Oxidation Ditch	Bio-P Removal Unknown
Feed Sludge Concentration	0.5	%
Sludge TDS	<800	mg/L
Sludge VSS	<62	%
Sludge pH	Approx 6.7	SU
Chloride Concentration	<200 (see notes on Chlorides)	mg/L
Phosphate Concentration	<50	mg/L
Nominal Hydraulic Loading Rate (per unit)	130 at 0.5% feed solids	gpm
Nominal Solids Loading Rate (per unit)	325 at 0.5% feed solids	lb/hr
Estimated Cake Solids ¹	17-19	%
Capture Rate ¹	≥ 95	%
Estimated Polymer Consumption ¹	14-19 lb active polymer/dry ton of sludge	
Average Spray Wash Water Requirement ²	84 gph at 72.5 psi	
Spray Water Connection	1.25	inch
Sludge Inlet Diameter	6	inch
Approximate Screw Press Empty Weight	8200	lbs
Approximate Screw Press Full Weight	10100	lbs

¹Estimated performance is based on HUBER pilot testing results.

²Wash water cycle runs at approximately 33 gpm for 152 seconds. Typical applications experience 1-2 wash cycles per hour.

Pilot Testing Results

Pilot Testing Conducted from 03/06/2023 through 03/10/2023	Best Results
Feed Solids Concentration	0.50%
Hydraulic Throughput	34.9 gpm
Solids Loading Rate	86 lb/hr
Cake Solids	17-19%
Polymer Consumption	14-16 lb active/dry ton

Equipment Details

Please note material of construction will be 316L stainless steel as shown in **Optional Equipment Adders**.

Model	HUBER Screw Press Q-PRESS 800.2®
Quantity	2
Material	304L stainless steel construction; pickled and passivated in acid bath
Basket Material	Wire mesh; stainless steel
Auger Inclination	10°
Support Legs	304L stainless steel
Wiper Material	Wear resistant polyurethane
Anchor Bolts	M12, 316L stainless steel
Motor Data	5 hp drive motor, 460 VAC, 60 Hz, 3 ph
Spraywash Motor Data	0.25 hp spraywash motor, 460 VAC, 60 Hz, 3 ph

Model	HUBER Screw Conveyor Ro8t 273 - Inclined Conveyor 1
Quantity	1
Material	304L stainless steel construction; pickled and passivated in acid bath
Length	Approximately 41 ft. 6 in.
Conveyor Inclination	Approximately 24°
Motor Data	1.5 hp drive motor, 460 VAC, 60 Hz, 3 ph
Additional Items	One (1) zero speed sensor & one (1) E-stop pull cord <i>(please note that these items are to be field installed by others)</i>

Model	HUBER Screw Conveyor Ro8t 273 - Inclined Conveyor 2
Quantity	1
Material	304L stainless steel construction; pickled and passivated in acid bath
Length	Approximately 31 ft. 0 in.
Conveyor Inclination	Approximately 34°
Motor Data	1.5 hp drive motor, 460 VAC, 60 Hz, 3 ph
Additional Items	One (1) zero speed sensor & one (1) E-stop pull cord <i>(please note that these items are to be field installed by others)</i>

Model	HUBER Screw Conveyor Ro8t 273 - Selector Conveyor
Quantity	1
Material	304L stainless steel construction; pickled and passivated in acid bath
Length	Approximately 28 ft. 4.5 in.
Conveyor Inclination	0°
Motor Data	1.5 hp drive motor, 460 VAC, 60 Hz, 3 ph (forward & reverse)
Additional Items	One (1) zero speed sensor & one (1) E-stop pull cord <i>(please note that these items are to be field installed by others)</i>

Model	HUBER Screw Conveyor Ro8t 273 - Distribution Conveyor 1
Quantity	1
Material	304L stainless steel construction; pickled and passivated in acid bath
Length	Approximately 14 ft. 7.25 in.
Conveyor Inclination	0°
Motor Data	1.5 hp drive motor, 460 VAC, 60 Hz, 3 ph (forward & reverse)
Additional Items	One (1) zero speed sensor & one (1) E-stop pull cord <i>(please note that these items are to be field installed by others)</i>

Model	HUBER Screw Conveyor Ro8t 273 - Distribution Conveyor 2
Quantity	1
Material	304L stainless steel construction; pickled and passivated in acid bath
Length	Approximately 14 ft. 7.25 in.
Conveyor Inclination	0°
Motor Data	1.5 hp drive motor, 460 VAC, 60 Hz, 3 ph (forward & reverse)
Additional Items	One (1) zero speed sensor & one (1) E-stop pull cord <i>(please note that these items are to be field installed by others)</i>

Model	Liquid Emulsion Polymer System Velodyne VM-1P-1200
Quantity	2
Neat Polymer Pump Motor	1/2 hp, 90 VDC
Mixer Motor	1/2 hp, 90 VDC

Ancillary Equipment	
Polymer Injection Ring	2, DN100 injection rings
Polymer Mixing Device	2, DN100 mixing valves
Sludge Flow Meter	2, 4-inch sludge flow meter
Air Compressor	Quantity: 2

Controls	Two (2) Main Screw Press Control Panel
Power Supply: 480VAC-3PH-60HZ	
Panel Classification: NONE	
Location: Indoors	
1 - Enclosure, NEMA 4X, 304 Stainless Steel, Wall Mount	
1 - Main Disconnect, Circuit Breaker Type, w/Through the Door Disconnect Handle	
1 - Variable Frequency Drive, PowerFlex 525 Series, with Branch Circuit Protection	
[5.0HP - Max, Press - PM Motor 7.5HP VFD]	
1 - Motor Starter, Reversing, IEC, w/Overload Relay and CB Branch Circuit Protection	
[0.25HP - 480VAC Max, Spray Drive]	
1 - Surge Protection, 120VAC	
1 - Phase Failure Voltage Monitoring Relay	
1 - Programmable Logic Controller, Allen-Bradley CompactLogix 5069 Series w/ Ethernet and Required IO	
1 - Operator Interface Unit, Allen-Bradley PanelView Plus, 7" Display	
1 - 24VDC Power Supply	
1 - Ethernet Switch, Unmanaged	
1 - Panel Heater, with Thermostat	
1 - Lot, Circuit Breakers, 120VAC: [As Required]	
1 - Lot, Pilot Lights, Transformer Type: [As Required]	
1 - Lot, Push Buttons: [As Required]	
1 - Lot, Selector Switches: [As Required]	
1 - Lot, Control Relays, Socket Type: [As Required]	
1 - Lot, Terminal Blocks: [As Required]	
1 - Lot, Dry Contacts: [As Required]	
1 - UL Label	
Remote ETHERNET signals to/from Q-Press Control Panel and SCADA System:	
(1) Lot, Dewatering System Status - To / From SCADA	
- SCADA Remote Start	
- Press Running Status	
- Press Fault Status	
- Dewatering Mode Status	
- System Disturbance Status	
Remote HARDWIRED signals to/from Q-Press Control Panel (Items either exist or provided by others):	
(1) Polymer Dosing System - To / From Polymer System	
- Call to Run	
- Pacing Signal, 4-20mA	
- System Auto Status	
- System Running Status	
- System Fault Status	
(1) Lot, Signals - To / From Feed Pump VFD	
- Call to Run	
- Pacing Signal, 4-20mA	
- System Auto Status	
- System Running Status	
- System Fault Status	
(1) Lot, Signals To / From Conveyor Control Panel	
- Call to Run	
- System Auto Status	
- System Running Status	

- System Fault Status

Controls	One (1) Main Screw Conveyor Control Panel
----------	---

Power Supply: 480VAC-3PH-60HZ

Panel Classification: NONE

Location: Indoors

1 - Enclosure, NEMA 4X, 304 Stainless Steel, Wall Mount

1 - Main Disconnect, Circuit Breaker Type, w/Through the Door Disconnect Handle

2 - Motor Starter, Non-Reversing, IEC, w/Overload Relay and CB Branch Circuit Protection

[1.5HP - 480VAC Max, Inclined Conveyor]

3 - Motor Starter, Reversing, IEC, w/Overload Relay and CB Branch Circuit Protection

[1.5HP - 480VAC Max, Distribution Conveyor]

5 - Current Monitor - Conveyors

1 - Surge Protection, 120VAC

1 - Phase Failure Voltage Monitoring Relay

1 - Programmable Logic Controller, Allen-Bradley Logix Series w/ Ethernet and Required IO

1 - Operator Interface Unit, Allen-Bradley PanelView Plus, 7" Display

1 - 24VDC Power Supply

1 - Ethernet Switch, Unmanaged

1 - Panel Heater, with Thermostat

1 - Lot, Circuit Breakers, 120VAC: [As Required]

1 - Lot, Pilot Lights, Transformer Type: [As Required]

1 - Lot, Push Buttons: [As Required]

1 - Lot, Selector Switches: [As Required]

1 - Lot, Control Relays, Socket Type: [As Required]

1 - Lot, Terminal Blocks: [As Required]

1 - Lot, Dry Contacts: [As Required]

1 - UL Label

Remote ETHERNET signals to/from Conveyor System Control Panel and SCADA System:

(1) Lot, Conveyor System Status - To / From SCADA

- (5) Running Status

- (5) Fault Status

Remote HARDWIRED signals to/from Q-Press Control Panel (Items either exist or provided by others):

(1) Lot, Signals To / From Q-Press Control Panel

- (2) Call to Run

- (2) System Auto Status

- (2) System Running Status

- (2) System Fault Status

Freight and Startup Services

6 days and 2 trips

Startup services for installation inspection and startup supervision.

Freight to jobsite.

Pricing

Equipment	Model	Quantity	Pricing
HUBER Screw Press	Q-PRESS 800.2®	2	Included
HUBER Conveyor System	Ro8T	5	Included
Polymer System	VM-1P-1200-D	2	Included
Ancillary Equipment			Included
HUBER Q-PRESS Control Panel		2	Included
HUBER Conveyor Master Panel		1	Included
Freight and Startup Services		6 days, 2 trips	Included
TOTAL:			TBD

Optional Equipment Adder	Model	Quantity	Adder Pricing
Additional Year of Warranty	24 mo. startup/30 mo. delivery	1	\$33,500.00
316L Stainless Steel Material of Construction*	Dewatering System	N/A	\$119,148.00

**Applies to HUBER Q-PRESS and Ro8t Screw Conveyors*



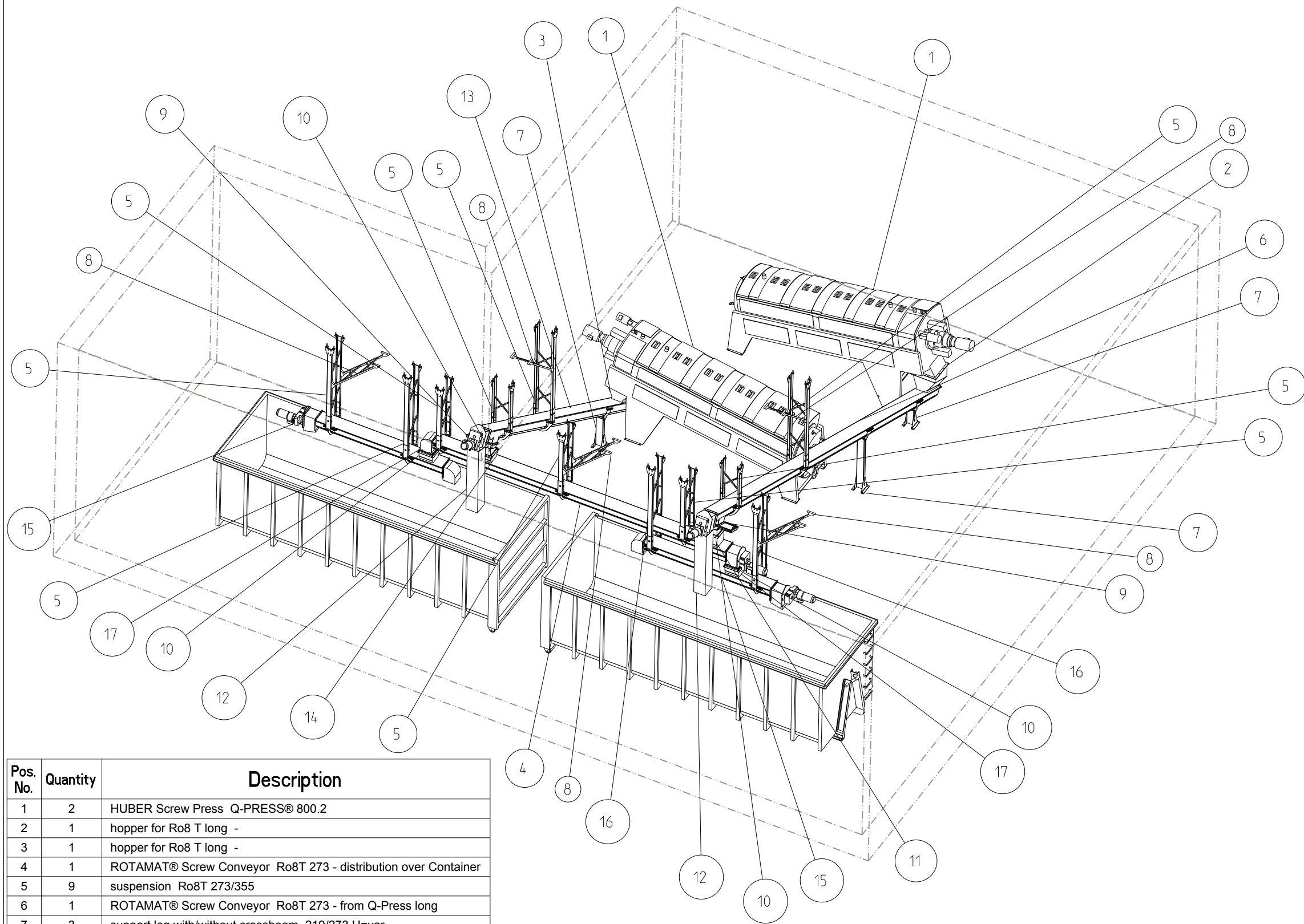
This proposal has been reviewed for accuracy and approved for issue by: JLH

This option was selected - 316L is the material of construction.

General Notes

1. HUBER has not received any bid documents. As such, HUBER has provided a standard offering per discussions with engineering team.
2. HUBER is in receipt of the following addenda:
No addenda.
3. All electrical interconnections, wirings, junction boxes, local motor disconnects, and terminations between the equipment and electrical components are to be provided by installing contractor.
4. Any item not specifically listed is not considered part of this scope of supply. Please contact the HUBER Technology representative listed for further clarification.
5. A fully functioning and programmed HMI/PLC will be delivered to site. Screens and symbols used on the HMI are based on HUBER's standard unless otherwise noted. Software licenses for the PLC/HMI program will not be included in this scope of supply unless stated otherwise. These items are available for additional price adder upon request.
6. The Control Panel is based on the specification provided and inclusive to meet the requirements of a Vendor designed panel, whereas the components and the factory testing of the panel will meet HUBER's requirements for function and warranty. Additional requirements or sections of the specification to meet local authority requirements or control panels designs unrelated to the equipment section, including special labeling, testing, or integration have not been included.
7. HUBER Technology, Inc. is offering the equipment and associated performance guarantees based on information available at the time of the issuance date. Information not made available to HUBER, whether HUBER is asking for specific information or not, which could affect the performance of the equipment might void warranty and performance guarantees.
8. HUBER will ship all equipment to site inside of 20', 40' or 40'OT ocean containers as deemed appropriate by our factory. HUBER will not ship any equipment on flatbed truck. Flatbed truck shipping means that the equipment would need to be transferred at port from factory packaged containers to the flatbed. This process is out of HUBER's control and it is our experience that equipment always gets damaged during this process.
9. HUBER's standard submittal documents, programming, testing procedure and O&M documentation are included.
10. Blue motor covers are aesthetic only, and have not been included in the HUBER Scope of Supply.
11. HUBER is supplying a 5 conveyor system consisting of two pushing, inclined conveyors and three distributing, horizontal conveyors. HUBER used measurements and angles shown in provided drawing.
12. While this proposal utilizes 304L as material of construction (as requested), HUBER has provided an optional adder to change the material of construction to 316L. This adder is inclusive of the wetted components of the dewatering system (presses and conveyors). Please note that the chloride concentrations were detected at levels known to adversely affect equipment constructed of 304L. See note Abrasion and Corrosive materials below.
13. Sludge feed pumps to be provided by others and have not been included in HUBER's scope of supply.
14. All piping between polymer injection and press inlet is to be supplied by others. HUBER requires a minimum of 45 seconds of retention time to allow for adequate flocculation. HUBER has included a sample flocculation piping report for reference.
15. Conveyors require some minor field assembly due to overall lengths. HUBER shall supply all necessary hardware for Contractor assembly. HUBER to supply assembly drawings for all conveyors.
16. HUBER requires pressurized water at 70-80 psi at their Q-PRESS and VeloDyne polymer system. Site should ensure instantaneous demand of up to 50 gpm is available.

SECTION 5
LAYOUT & MECHANICAL DRAWINGS



Pos. No.	Quantity	Description
1	2	HUBER Screw Press Q-PRESS® 800.2
2	1	hopper for Ro8 T long -
3	1	hopper for Ro8 T long -
4	1	ROTAMAT® Screw Conveyor Ro8T 273 - distribution over Container
5	9	suspension Ro8T 273/355
6	1	ROTAMAT® Screw Conveyor Ro8T 273 - from Q-Press long
7	3	support leg with/without crossbeam 219/273 H=var.
8	5	strengthening 1200/1200/ 40
9	2	gate valve 273 manually L300
10	4	chute with neoprene flap flexibel
11	1	hopper for Ro8 T long -
12	2	chute rotatable - fix part 273
13	1	ROTAMAT® Screw Conveyor Ro8T 273 - from Q-Press short
14	1	hopper for Ro8 T long -
15	2	ROTAMAT® Screw Conveyor Ro8T 273 - Container 01
16	2	suspension Ro8T 273/355
17	2	hopper for Ro8 T long -

- material of construction = 304 stainless steel
- motor and solenoids = Class 1, Division 1

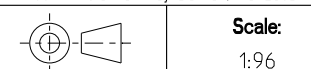
WARNING:
Moving machine parts. Protection against accidental contact to be supplied by client according to country specific regulations.

Fall protection to be supplied by client (type of protection acc. to country specific regulations). (also valid for planned or existing covers of channel > 3*Min> - 7 1/4<Sec> height)

NO AREA GRINDING OF NON-STAINLESS WELDS OR MATERIALS PERMITTED NEAR THE HUBER EQUIPMENT. CONTRACTOR TO INSPECT HUBER EQUIPMENT AND PROPERLY REMOVE/CLEAN ANY IRON PARTICULATES OCCURRING FROM AREA WELDING AND GRINDING RELATED OR UNRELATED OF THE HUBER INSTALLATION.

Note:	
N1	Compliance of the machinery directive: For the planning and building construction security precautions, safety requirements as well as country specific regulations must be respected.
N2	Anchore base: Normal reinforced concrete, concrete strength minimal C20/25 up to a maximum of C50/60. (minimum component thickness 160 mm) Anchor type: Fa. Hilti AG, type: stud anchor HST2-R M16x140/25 or equivalent Material: Stainless steel A4
N3	The firm standing of the machine is only guaranteed after anchoring!
N4	Equipotential bonding Connection point for protective conductor size M8: (grounding cable 10 mm ² copper) Connection point for the connection to the main equipotential bonding according to DIN EN 60204-1 (VDE 0113-1). The local safety measures according to the guidelines (DIN, VDE, EN, ATEX) must be noted.
N8	Machines longer than 7200 mm needs a second support leg
N9	Machines longer than 6550mm require a different type of motor.
N10	Tank must not be damaged. Free drain of the tank must be guaranteed! Additional drain pipe >= 4 per thousand
N11	Additional loads (e. g. pipelines, service platforms,...) on our plant are not allowed
N15	The minimum passage of 2100 mm is not satisfied. The danger zone have to be marked with yellow/black marker tape by customer.
N16	Safe access to the inspection cover of the tank (control, cleaning, maintenance) must be provided by a permanent or mobile operating platform according to the certified safety regulations.
N17	Comply with safety distances for reaching and passing through to solid discharge: Chute / shaft (H > 550mm) closed on all sides optional or customer supplied (slot opening at flange <= 20mm). Alternatively provide protective structures! At discharge heights over 2500mm no additional attachments nessesery.

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	Name	Date
Designed:	hec	25.05.2023
Approved:	ll	ll
Modified:	-	-
Rev.	Modification	



HUBER Screw Press		
Q-PRESS® 800.2		
Fig. No.: 1/6	Installation drawing	Size: B
KA Mount Clemens		Drawing No.: 52091854

GENERAL INSTALLATION NOTES:


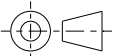
1.	EQUIPMENT MUST BE LEVEL IN ALL PLANES.
2.	AUTHORIZATION REQUIRED FOR FIELD MODIFICATIONS TO HUBER EQUIPMENT DUE TO SITE INCONSISTANCIES -CONTACT HUBER TECHNOLOGY.
3.	REFUSE CONTAINERS SHOWN ON DRAWINGS (IF ANY) ARE FOR REFERENCE ONLY AND ARE SUPPLIED BY OTHERS (UNLESS SPECIFIC TO HUBER'S SCOPE OF SUPPLY.)
4.	WELDING: DO NOT WELD UNTIL TEMPORARY MOCK-UP IS VERIFIED AGAINST THE INSTALLATION DRAWINGS AND ALL LEVEL, SQUARENESS, AND/OR ANGLES HAVE BEEN ACHIEVED -REFER TO WELD SPECIFICATIONS THIS DRAWING.
5.	INSTALLATION CONTRACTOR TO VERIFY ALL EXISTING STRUCTURAL DIMENSIONS BEFORE COMMENCEMENT OF WORK. CONTACT ENGINEER AND/OR HUBER IF FIELD DISCREPANCIES PREVENT PROPER INSTALLATION AS SHOWN ON THE INSTALLATION DRAWINGS, AND/OR OPERATIONS AND MAINTENANCE MANUAL.
6.	FIELD VERIFY ALL EXISTING SITE DIMENSIONS AND ELEVATIONS. DIMENSIONS AND ELEVATIONS SHOWN ARE BASED ON ENGINEERING DRAWINGS AVAILABLE AT THE TIME OF DESIGN OR AS BASED ON AVAILABLE PLANT RECORD DRAWINGS -ALL SITE DIMENSIONS SHOWN ON HUBER DRAWINGS ARE FOR "REFERENCE" ONLY. HUBER NOT RESPONSIBLE FOR DISCREPANCIES IN THE FIELD.
7.	INSTALLATION IS BY OTHERS.
8.	ALL REQUIRED ELECTRICAL, FITTINGS, CONDUIT, HAZARDOUS AREA CONDUIT SEALS, WIRING, AND/OR JUNCTION BOXES - ARE SUPPLIED BY OTHERS.
9.	REFER TO PROJECT DRAWINGS OR CONSULT ENGINEER FOR EQUIPMENT CONDUIT RUNS, CONTROL STATION LOCATION, AND FLOOR STUB UPS.
10.	VALVES SUPPLIED SEPARATE (IF ANY) MUST BE FIELD INSTALLED BY INSTALLING CONTRACTOR. ALL PIPE RUNS AND REQUIRED PIPING ARE SUPPLIED BY OTHERS. SEE ENGINEER FOR PIPE LAYOUT/ROUTING.
11.	FLANGE GASKETS, HARDWARE, AUXILIARY PIPING, FITTINGS, OR OTHER RELATED ARE SUPPLIED BY OTHERS (UNLESS SPECIFICALLY INCLUDED AS PART OF HUBER'S EQUIPMENT SUPPLY).
12.	EQUIPMENT ANCHORS AND HARDWARE SUPPLIED BY HUBER ARE METRIC.
13.	REFER TO EQUIPMENT OPERATIONS AND MAINTENANCE MANUAL FOR DETAILED INSTALLATION INSTRUCTIONS AND/OR EQUIPMENT SPECIFIC INFORMATION.
14.	CONSUMABLES ARE NOT PROVIDED BY HUBER

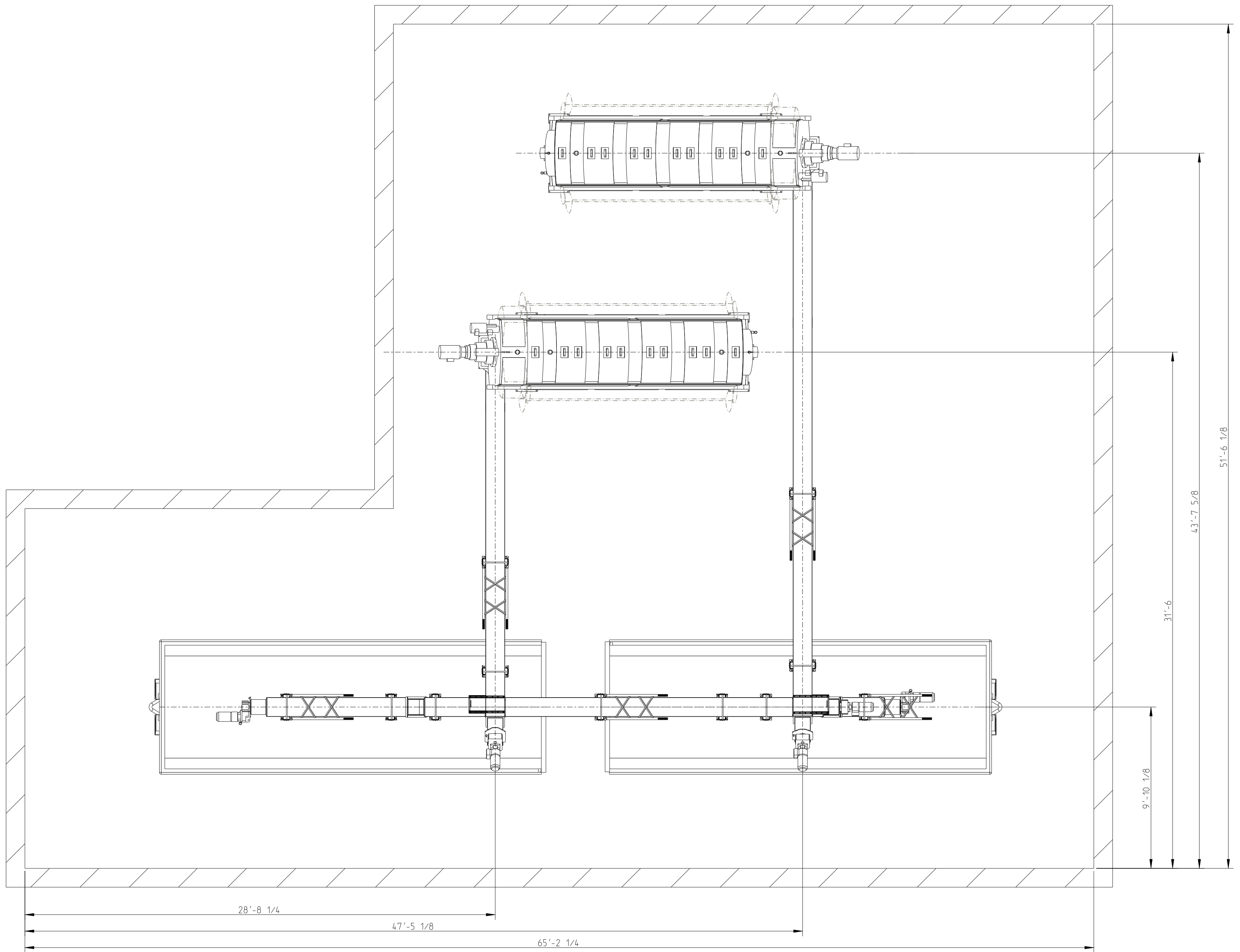
WELDING SPECIFICATIONS:

1.	NO AREA GRINDING OF NON-STAINLESS METALS OR IRON WELDS PERMITTED NEAR HUBER EQUIPMENT. CONTRACTOR TO INSPECT HUBER EQUIPMENT FOR "RUST SPECKS" IF IRON DUST IS SUSPECT. ALL "RUST SPECKS" MUST BE EXPEDITENTLY AND PROPERLY CLEANED.
2.	WELD ELECTRODES (USED ON HUBER EQUIPMENT) MUST BE AS FOLLOWS:
2. a	304L EQUIPMENT USE 308L ELECTRODE OR BETTER.
2. b	316L EQUIPMENT USE 316L ELECTRODE OR BETTER.
3.	REMOVE ALL BURRS AND SHARP EDGES FROM FIELD WELDS.
4.	ALL WELD AREAS TO BE CLEANED WITH SOLVENT MEK OR EQUIVALENT.
5.	WELDING PER AWS & ASME STANDARDS.

ELECTRICAL NOTES:

1.	ELECTRICAL FITTINGS, WIRING, FLEX CONDUIT/POWER CABLE, SO-CORD, JUNCTION BOXES, REQUIRED FOR MOTOR POWER ARE SUPPLIED BY OTHERS AND NOT PROVIDED BY HUBER.
2.	EQUIPMENT MOTORS SHOULD BE DIRECT WIRED UTILIZING CLASS 1, DIVISION 1 APPROVED FLEX CONDUIT OR OTHER AS APPROVED BY THE ENGINEER.
3.	EQUIPMENT MOTORS DO NOT COME PREWIRED AND REQUIRE CLASS 1, DIVISION 1 PROCEDURES.
4.	CONTRACTOR IS RESPONSIBLE FOR ALL APPLICABLE ELECTRICAL CODE PROCEDURES AND STANDARDS GOVERNING THE PROJECT LOCAL. FOR HAZARDOUS AREA ELECTRICAL CLASS 1, DIVISION 1, GROUP D, NEC ARTICLE 501 SHALL GOVERN.

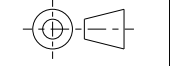
Intellectual property of HUBER Technology, Inc. Technical Information subject to change.		 HUBER TECHNOLOGY WASTE WATER Solutions 1009 Airlie Parkway Denver, NC 28037	HUBER Screw Press							
			Q-PRESS® 800.2							
Designed:	hec	25.05.2023		Scale:	1:48	Fig. No:	2/6	Installation drawing	Size:	B
Approved:	II	II								
Modified:	-	-								
Rev.	Modification							KA Mount Clemens	Drawing No:	52091854



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 Technical Information subject to change.

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Designed:	hec	25.05.2023
Approved:		
Modified:	-	-
Rev.	Modification	

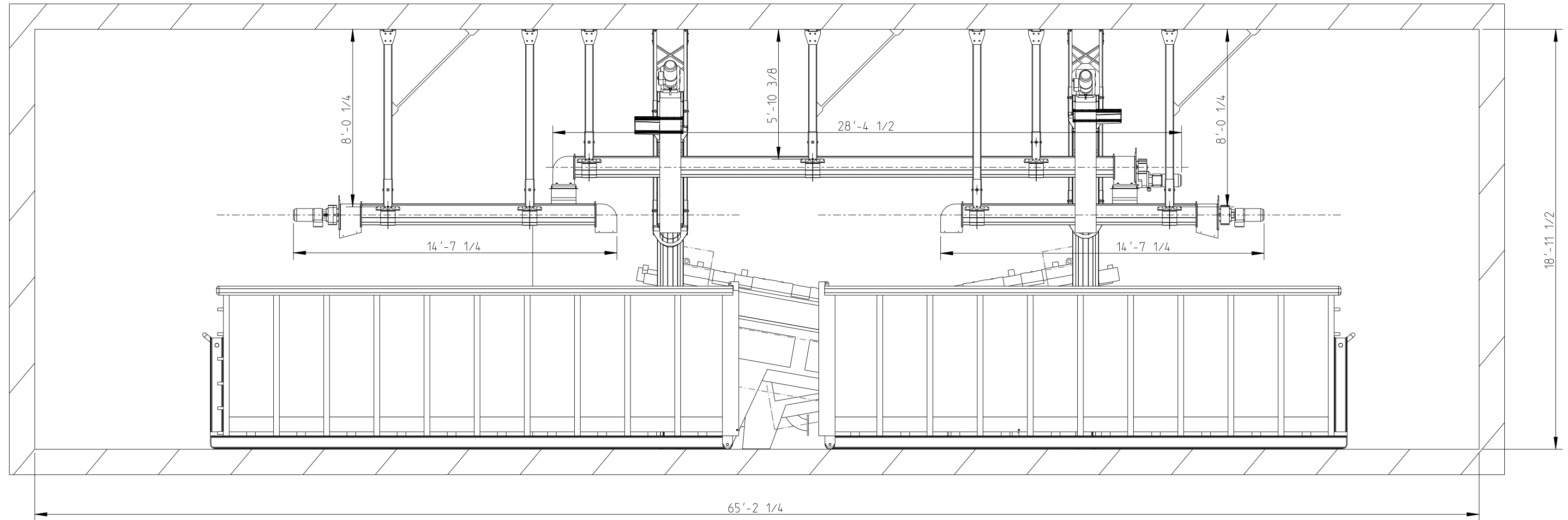
HUBER
TECHNOLOGY
 WASTE WATER Solutions
 1009 Airlie Parkway Denver, NC 28037


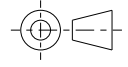


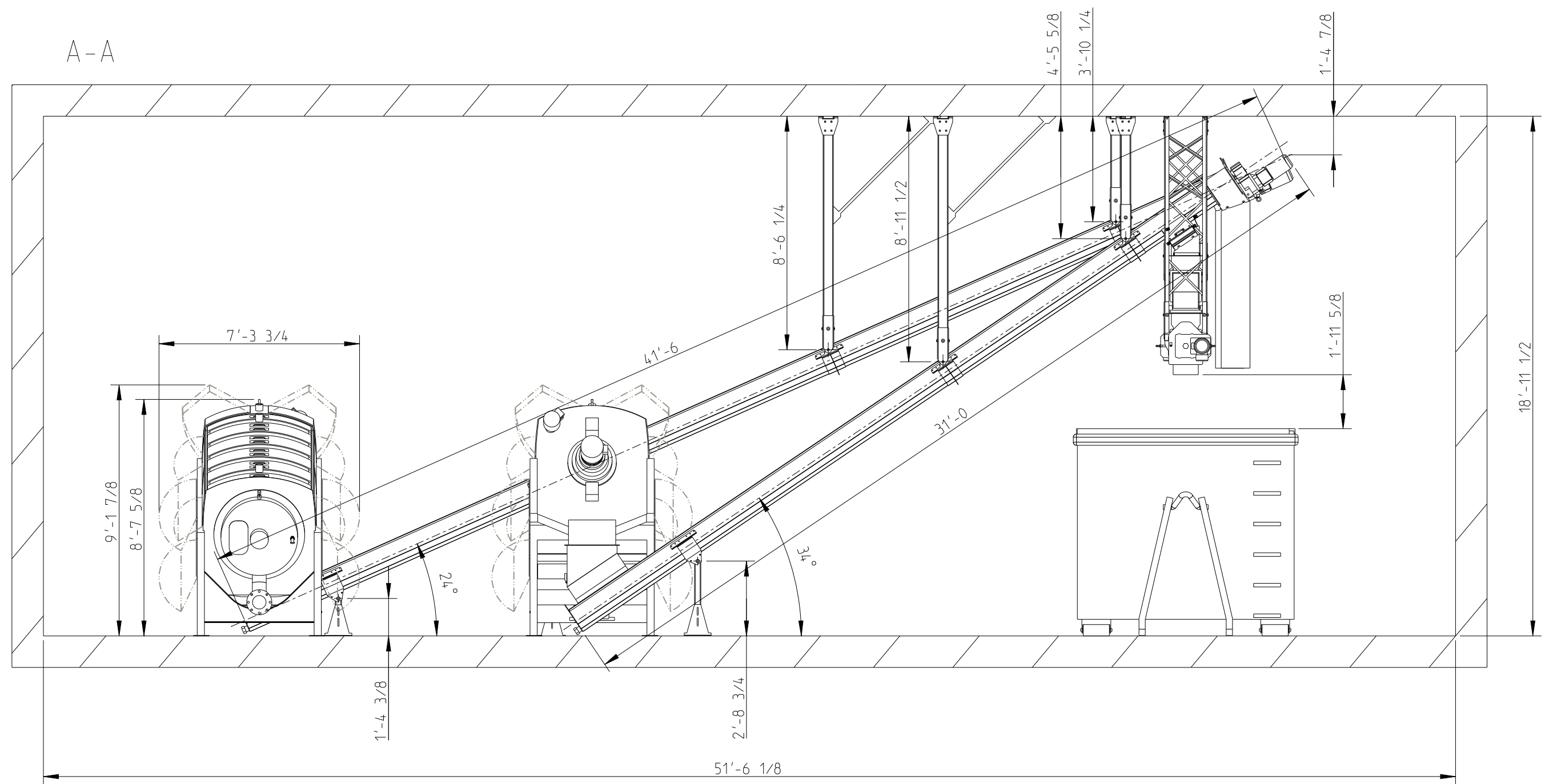
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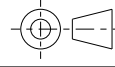
HUBER Screw Press		
Q-PRESS® 800.2		
Fig. No: 3/6	Installation drawing	Size: C
KA Mount Clemens		Drawing No: 52091854

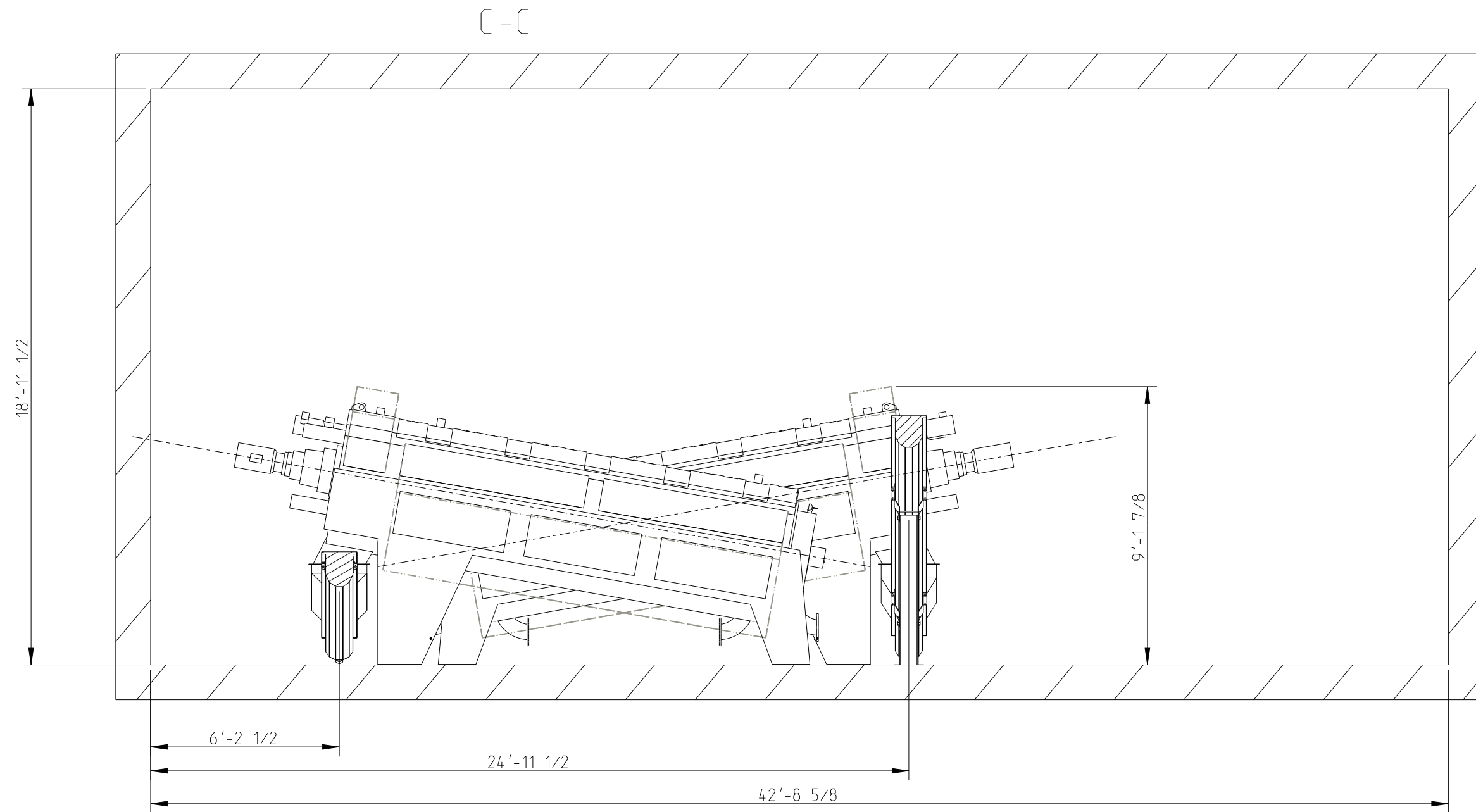
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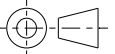


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				Q-PRESS® 800.2						
Designed:	hec	25.05.2023		Scale:	1:48	Fig. No.:	4/6	Installation drawing	Size:	C
Approved:				Rev.:			KA Mount Clemens		Drawing No.:	52091854
Modified:	-	-		Modification						



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				Q-PRESS® 800.2		
Designed:	hec	25.05.2023		Scale:	Fig. No:	Size:
Approved:				1:48	5/6	Installation drawing
Modified:	-	-	KA Mount Clemens			Drawing No:
Rev.	Modification					52091854



Intellectual property of HUBER Technology, Inc. Technical Information subject to change.			HUBER TECHNOLOGY WASTE WATER Solutions 1009 Airlie Parkway Denver, NC 28037		HUBER Screw Press		
					Q-PRESS® 800.2		
	Name	Date		Scale:	Fig. No.:	Installation drawing	Size:
Designed:	hec	25.05.2023		1:4.8	6/6		B
Approved:							
Modified:	-	-					
Rev.	Modification			KA Mount Clemens			Drawing No.: 52091854

SECTION 6
ELECTRICAL & CONTROLS DRAWINGS

Electrical Drawings



Rev: 0

Date: 11-21-2023

By: JN

Section:

C

Job Number: HBR9465

Page # 1/1

Section Name: Electrical Drawings

MT. CLEMENS, MI	
HBR9465	
SPECIFICATION	CONVEYOR CONTROL PANEL
REFERENCE	73010851

TABLE OF CONTENTS	
DESCRIPTION	DRAWING SHEET NO.
COVER PAGE	HBR9465A01
CONTROL PANEL SPECIFICATION	HBR9465A02
ELECTRICAL SCHEMATICS	HBR9465A03
FIELD WIRING DIAGRAM	HBR9465A12
PLC IO & DEVICE SETPOINTS	HBR9465A13
SEQUENCE OF OPERATION	HBR9465A15
ENCLOSURE LAYOUT	HBR9465A16
NAMEPLATE AND LABEL SCHEDULE	HBR9465A17

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					DETAILED	
					CHECKED	MSN
					APPROVED	
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CONVEYOR CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9465A01
1 OF 17	

Control Panel Enclosure

Rating:	NEMA TYPE 4X
Material:	304 SS
Disconnect Type:	Door Interlock - Non-Fused
<input checked="" type="checkbox"/> Drip Shield	<input type="checkbox"/> 3-PT Latch
<input type="checkbox"/> Outdoor - Direct Sunlight	<input type="checkbox"/> Indoor - Conditioned
Environment Max Temperature Rating (°F):	119
Internal Device Max Temperature Rating (°F):	122
Climate Control Type:	NEMA 4X Filter Fan

Panel Construction

Certification:	UL698A
Listing Serial Number:	TBD
<input checked="" type="checkbox"/> Phase Failure Relay	<input type="checkbox"/> Alarm Beacon
Nameplates and Legendplates:	Thermal Printed
Attachment Type:	Adhesive
Colors:	Background: White Text: Black
Wire/ Cable Type:	Wire Color:
Wiring to be 14 AWG unless otherwise specified. 16 AWG minimum. Wire shall be MTW type, tinned copper, 600VAC, 105°C, UL1015/CSA.	Black - Power Black - 120VAC Hot White - 120VAC Neutral Red - 120VAC Control Yellow - Foreign Voltage Green - Ground Blue - DC Positive White/Blue - DC Negative
Analog signal wiring shall be 18 AWG shielded twisted pair rated 300V.	Wire Labels: <input checked="" type="checkbox"/> Adhesive, Self-laminating <input type="checkbox"/> Heat Shrink
Ethernet cables shall be 24AWG rated 600V. Cat5E.	Note: Colors based on UL508A requirements.
Fiber cables shall be SC-Duplex, 50µm multimode.	

Local Enclosure

Tag:	ZSC1-5	Rating:	NEMA 4X	Material:	Fiberglass
------	--------	---------	---------	-----------	------------

Power and Motor

Power Feed:	Circuit 1 : 480 VAC 12.6 FLA SCCR 5 KAIC @ 480 VAC
Motor Data:	Motor 1 : 460 VAC 2.2A FLA 1.5 HP Controller: FVNR
	Motor 2 : 460 VAC 2.2A FLA 1.5 HP Controller: FVNR
	Motor 3 : 460 VAC 2.2A FLA 1.5 HP Controller: FVR
	Motor 4 : 460 VAC 2.2A FLA 1.5 HP Controller: FVR
	Motor 5 : 460 VAC 2.2A FLA 1.5 HP Controller: FVR

Networking

Communication Type:	Ethernet/ IP		
Subnet:	255.255.255.0	Gateway:	0.0.0.0
IP Address:	TBD		
PLC1:	TBD		
OIU1:	TBD		
Programming:	PLC1: CompactLogix 5069-L306ER Software: Studio 5000 Version: Latest		
	OIU: PanelView Plus 7" Software: FactoryTalk View ME Version: Latest		
Notes:	1. PLC shall be programmed with ladder type only. 2. HMI shall be developed using EleMech's standard Global Object Library.		

Instrumentation

Tag:	ZSS1-5	Cable Length:	N/A
Rating:	<input checked="" type="checkbox"/> Non-Hazardous <input type="checkbox"/> Class 1, Division 2	<input type="checkbox"/> Intrinsically Safe Class 1 Division 1,2 <input type="checkbox"/> Class 1 Division 1,2	
Tag:	PCI-5	Cable Length:	50FT
Rating:	<input checked="" type="checkbox"/> Non-Hazardous <input type="checkbox"/> Class 1, Division 2	<input type="checkbox"/> Intrinsically Safe Class 1 Division 1,2 <input type="checkbox"/> Class 1 Division 1,2	

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CONVEYOR CONTROL PANEL

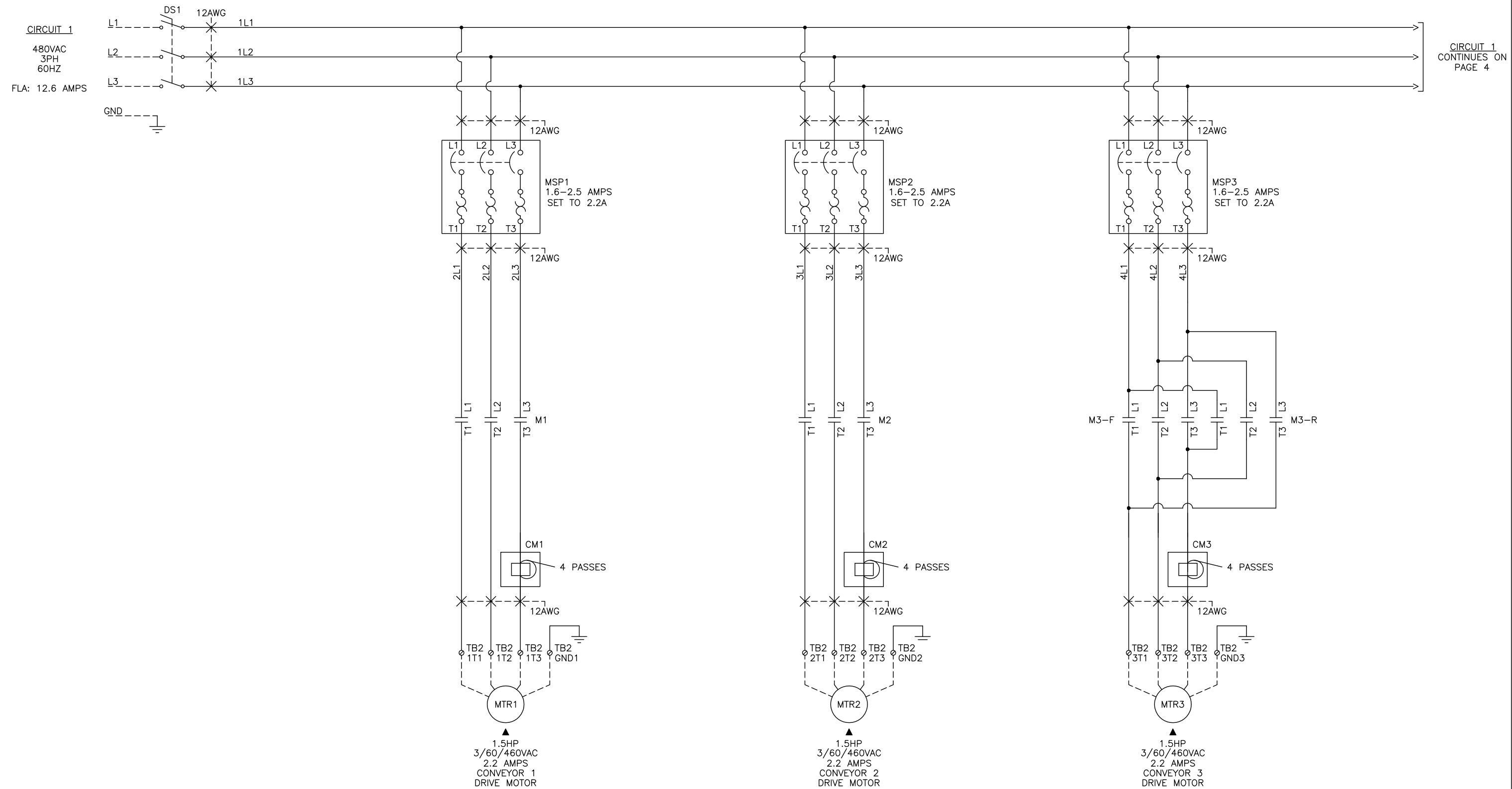
MT. CLEMENS, MI

SCALE: NONE

PROJECT NUMBER: 73010851

DRAWING NO: HBR9465A02

2 OF 17



NOTES:

1. ▲ DEVICES LOCATED OUTSIDE CONTROL PANEL.
2. ∅ TERMINAL BLOCK (TB) OR DISTRIBUTION BLOCK (DB) LOCATED IN CONTROL PANEL.
3. --- FIELD WIRING.
4. ELEMECH RESERVES THE RIGHT TO CHANGE, AS NECESSARY, THE SPACING, ORIENTATION, AND PHYSICAL LOCATION OF DEVICES IN ORDER TO OPTIMIZE THE DESIGN.
5. LOCAL MOTOR DISCONNECT SWITCHES SHALL BE PROVIDED BY OTHERS IF REQUIRED BY LOCAL REGULATIONS.
6. JUNCTION BOXES ARE NOT SHOWN AND SHALL BE PROVIDED BY OTHERS AS NECESSARY.

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CONVEYOR
CONTROL PANEL

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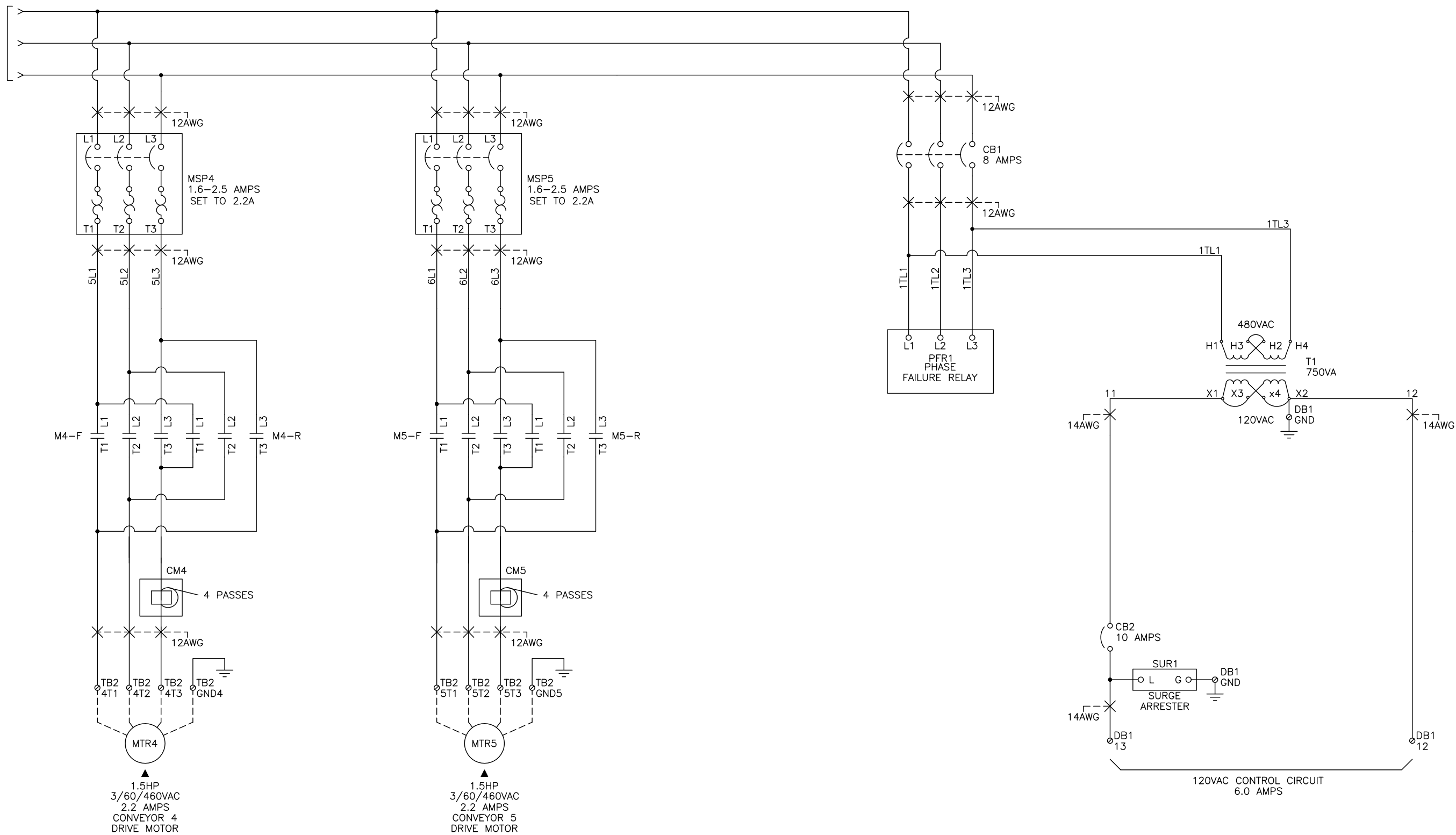
SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9465A03

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CIRCUIT 1
CONTINUED FROM
PAGE 3



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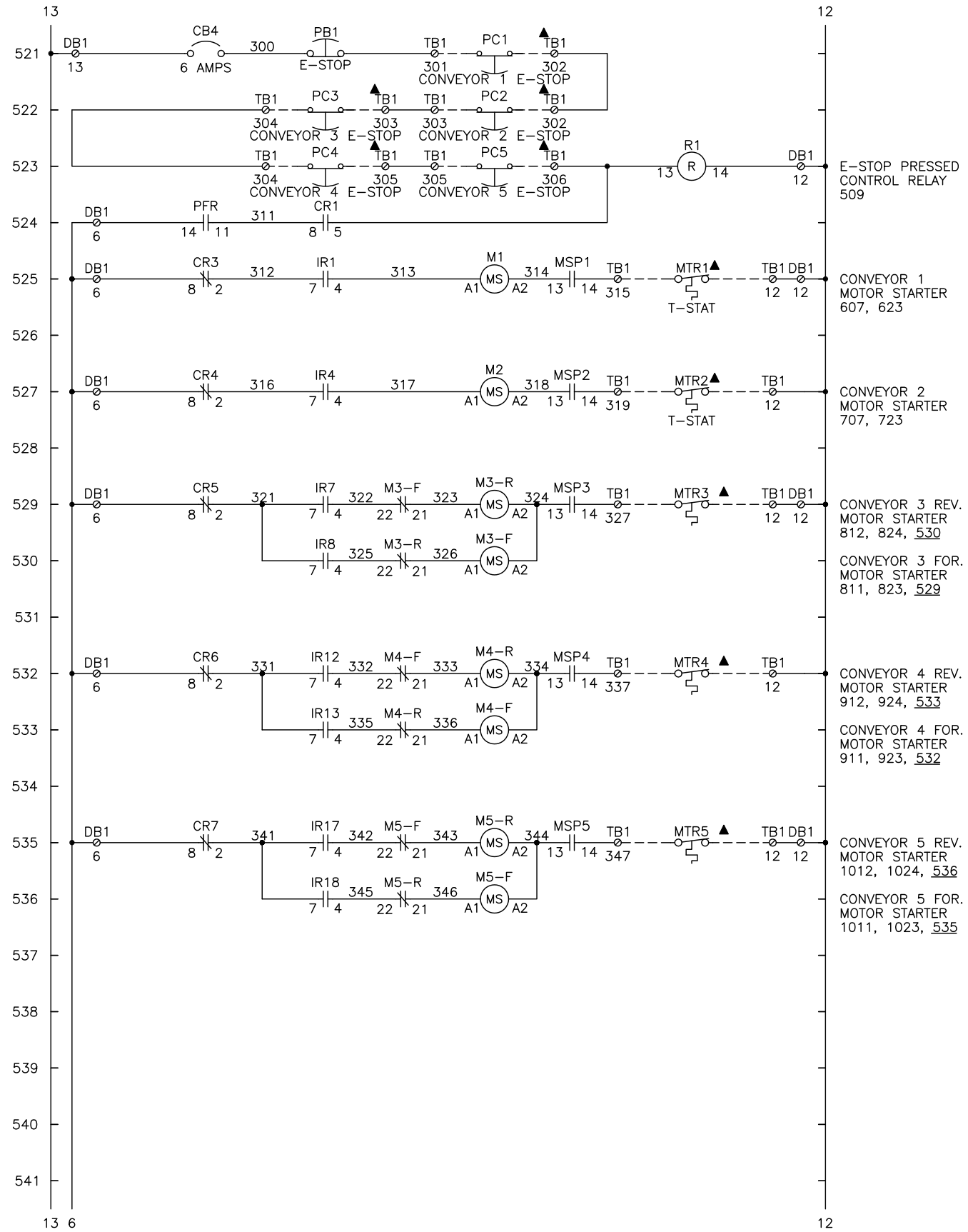
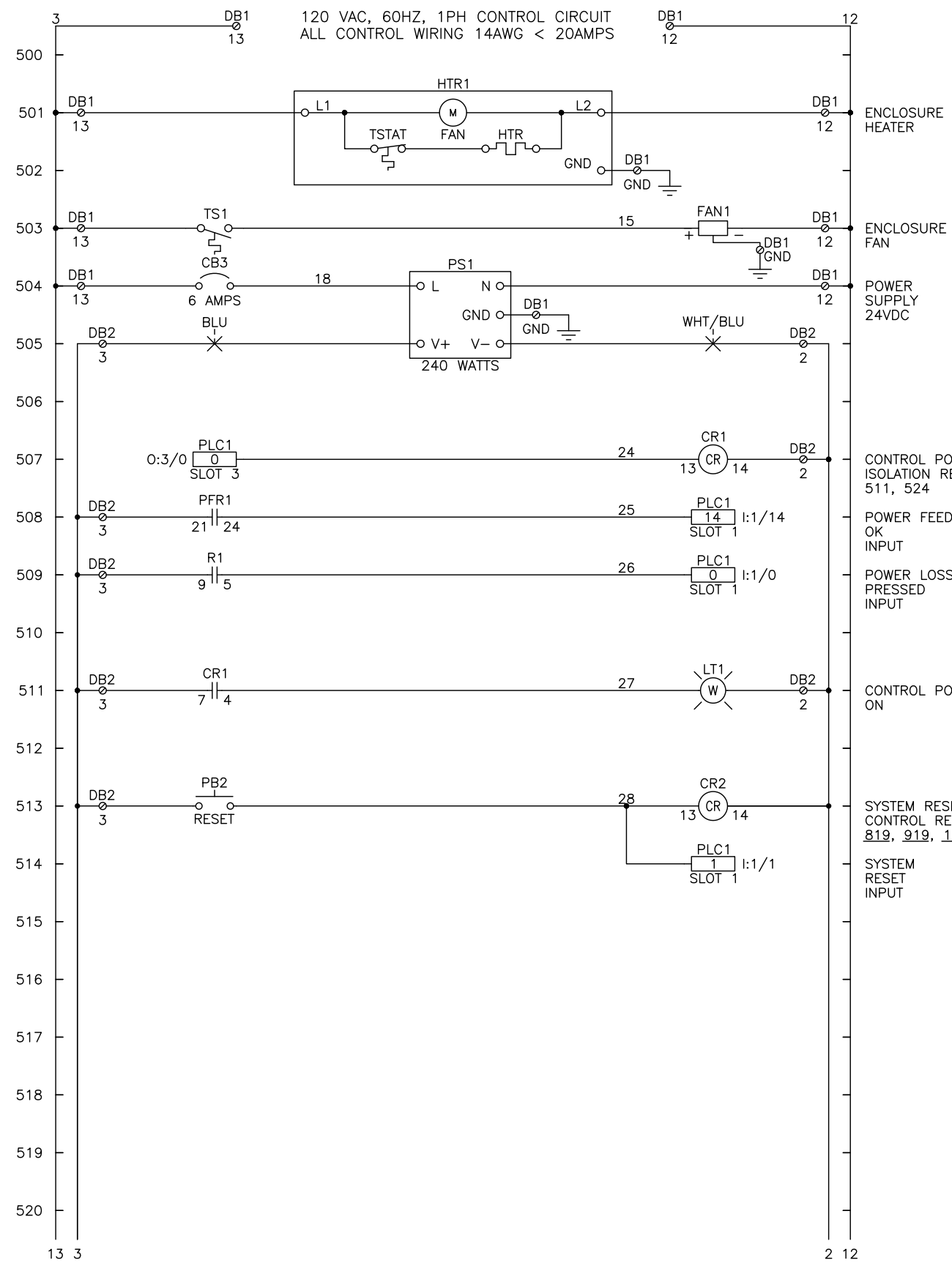
MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9465A04

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CONVEYOR CONTROL PANEL

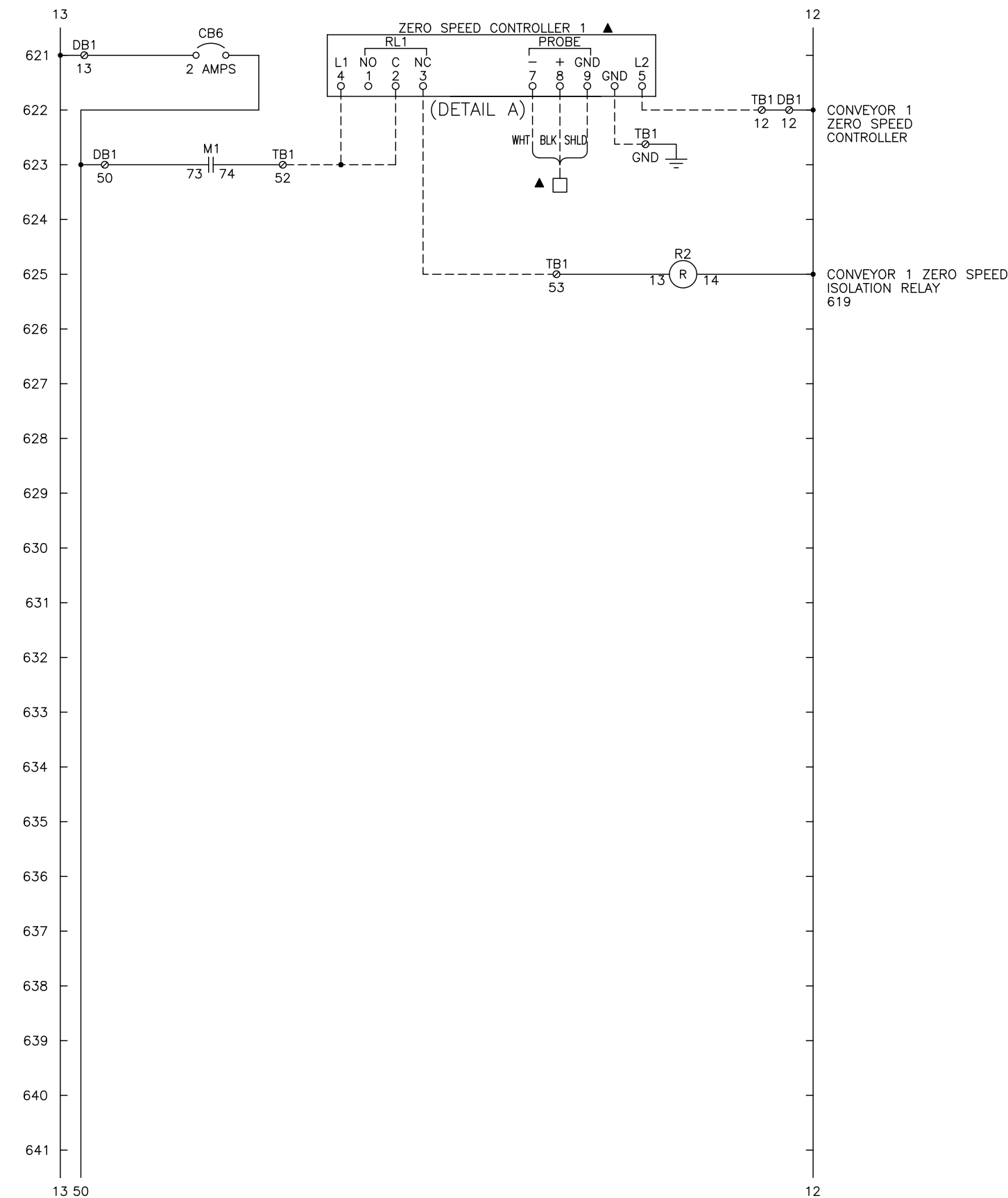
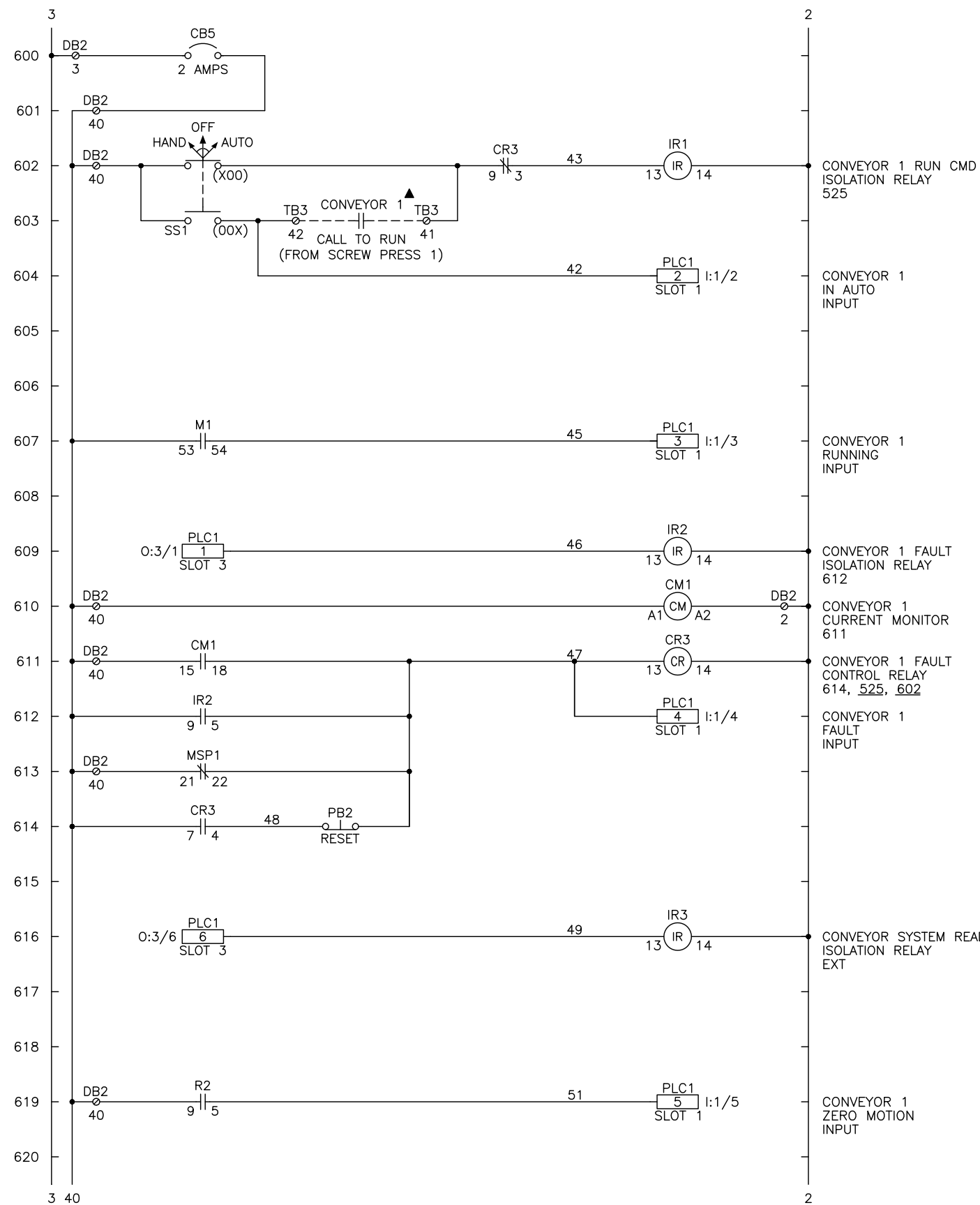
MT. CLEMENS, MI

PROJECT NUMBER: 73010851

DRAWING NO: HBR9465A05

SCALE: NONE

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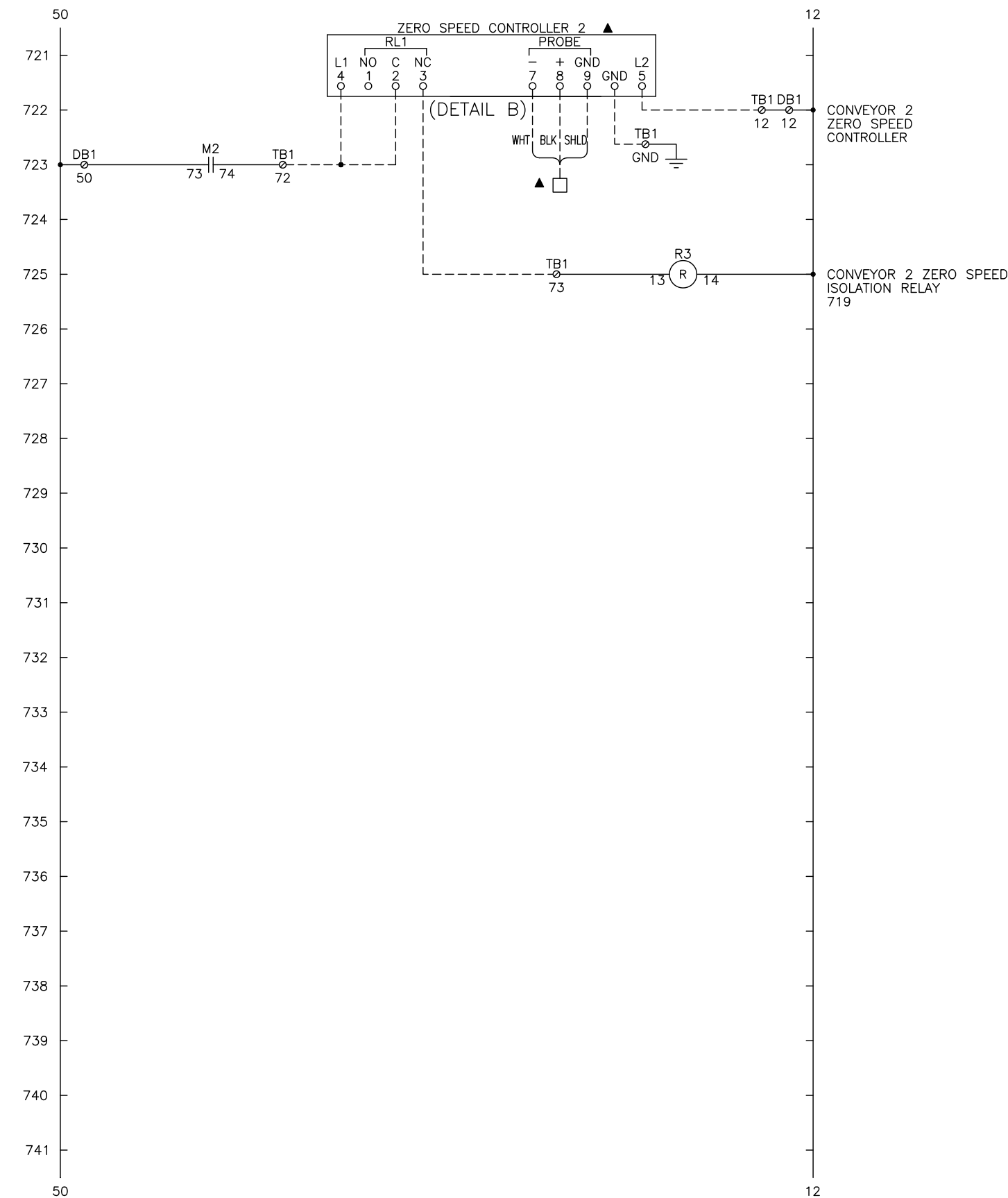
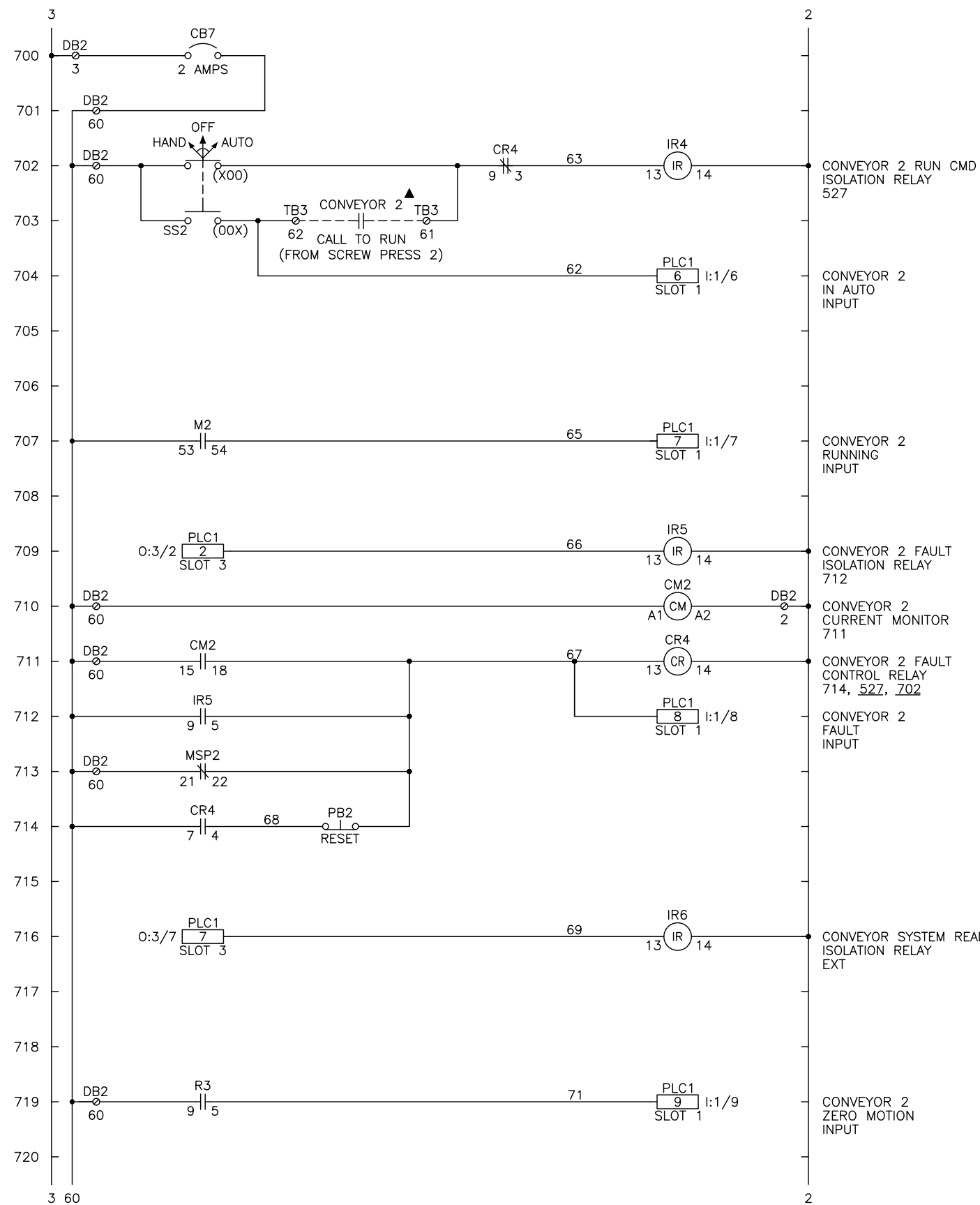
MT. CLEMENS, MI

PROJECT NUMBER: 73010851

DRAWING NO: HBR9465A06

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SCALE: NONE



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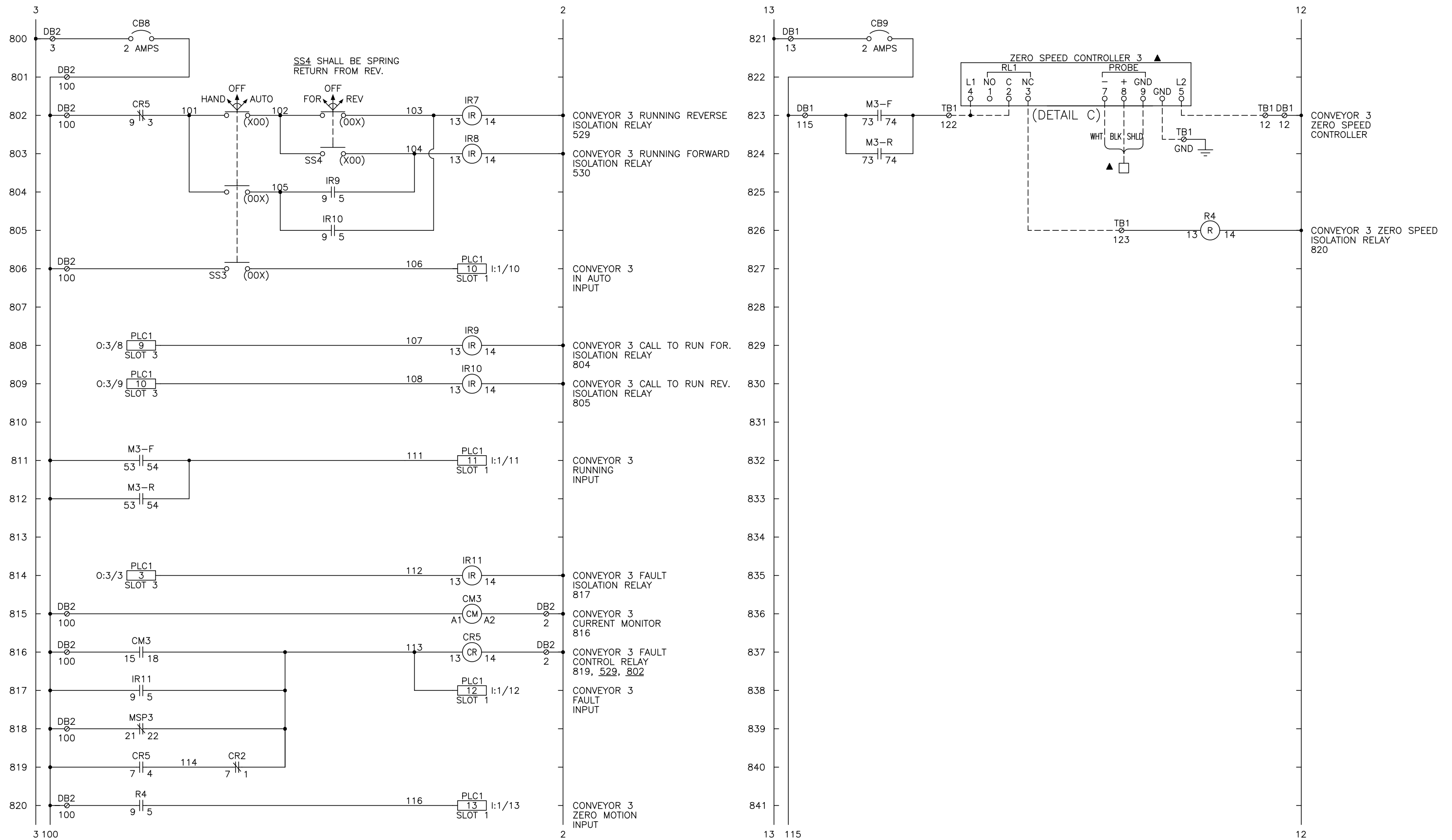
MT. CLEMENS, MI

PROJECT NUMBER: 73010851

DRAWING NO: HBR9465A07

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SCALE: NONE

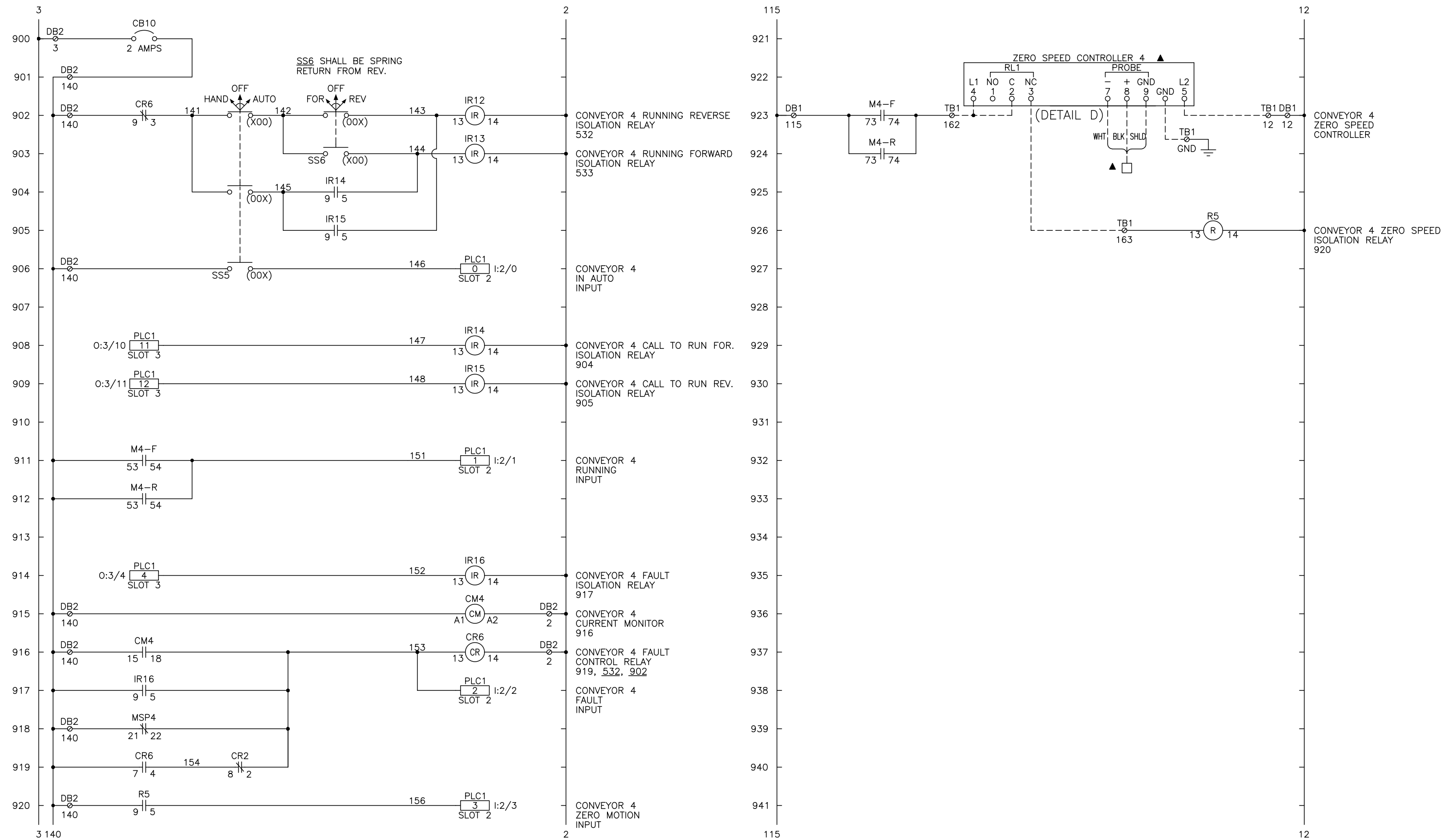


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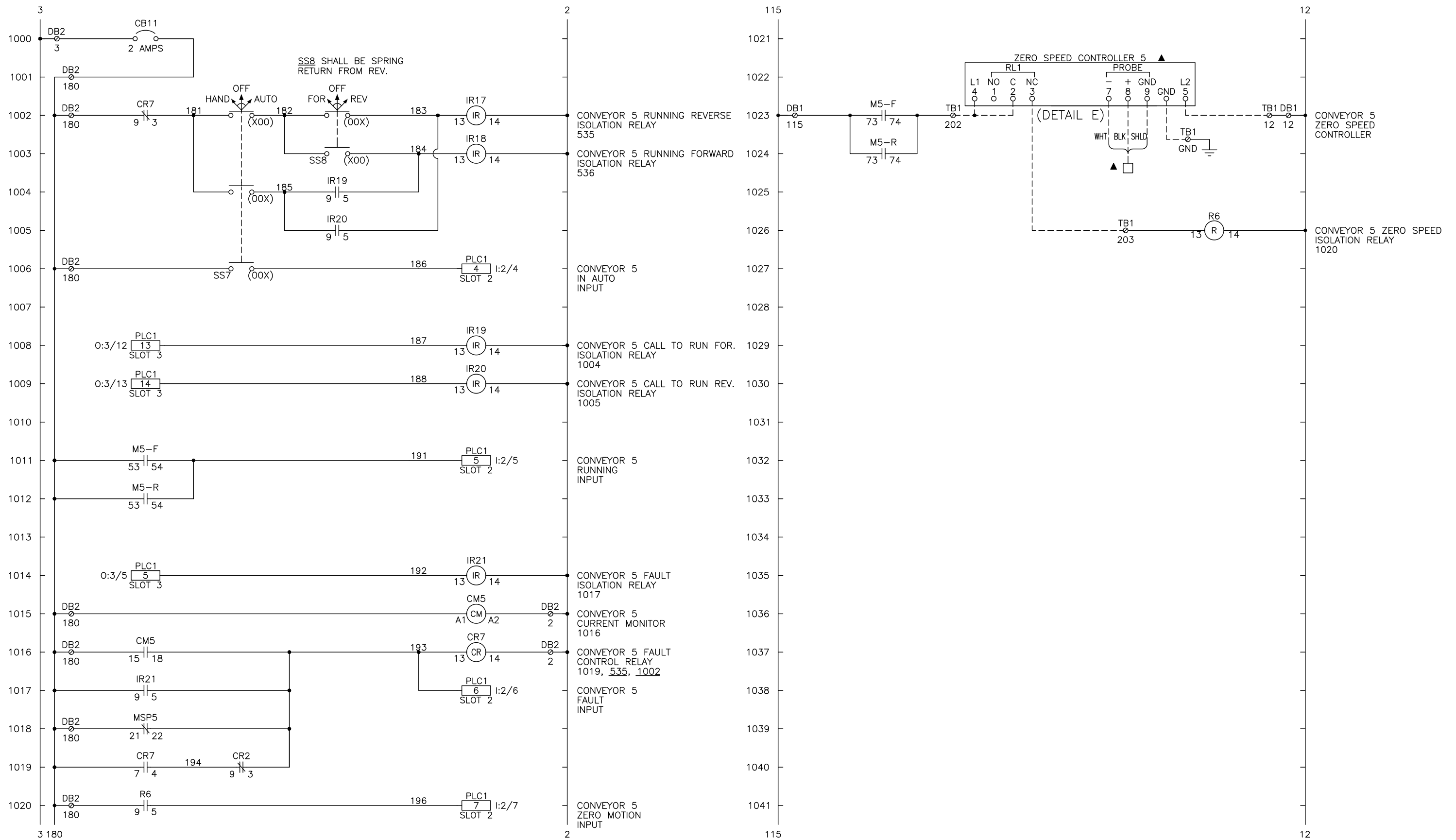
CONVEYOR CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9465A08
8 OF 17	



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PROJECT NUMBER: 73010851 DRAWING NO: HBR9465A09
9 OF 17



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CONVEYOR CONTROL PANEL

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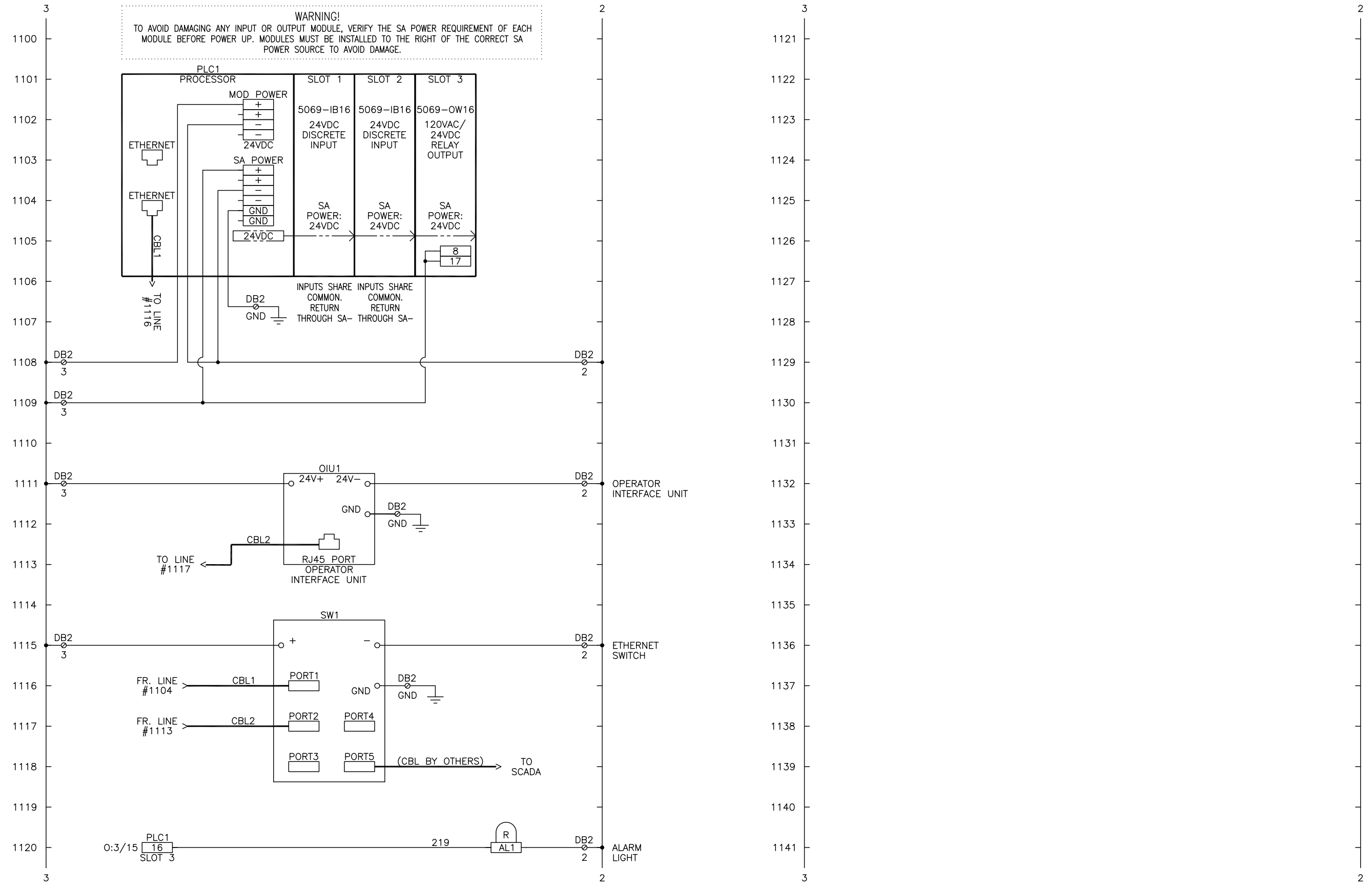
SCALE: NONE

PROJECT NUMBER: 73010851

DRAWING NO: HBR9465A10

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WARNING!
 TO AVOID DAMAGING ANY INPUT OR OUTPUT MODULE, VERIFY THE SA POWER REQUIREMENT OF EACH MODULE BEFORE POWER UP. MODULES MUST BE INSTALLED TO THE RIGHT OF THE CORRECT SA POWER SOURCE TO AVOID DAMAGE.



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CONVEYOR CONTROL PANEL

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SCALE: NONE

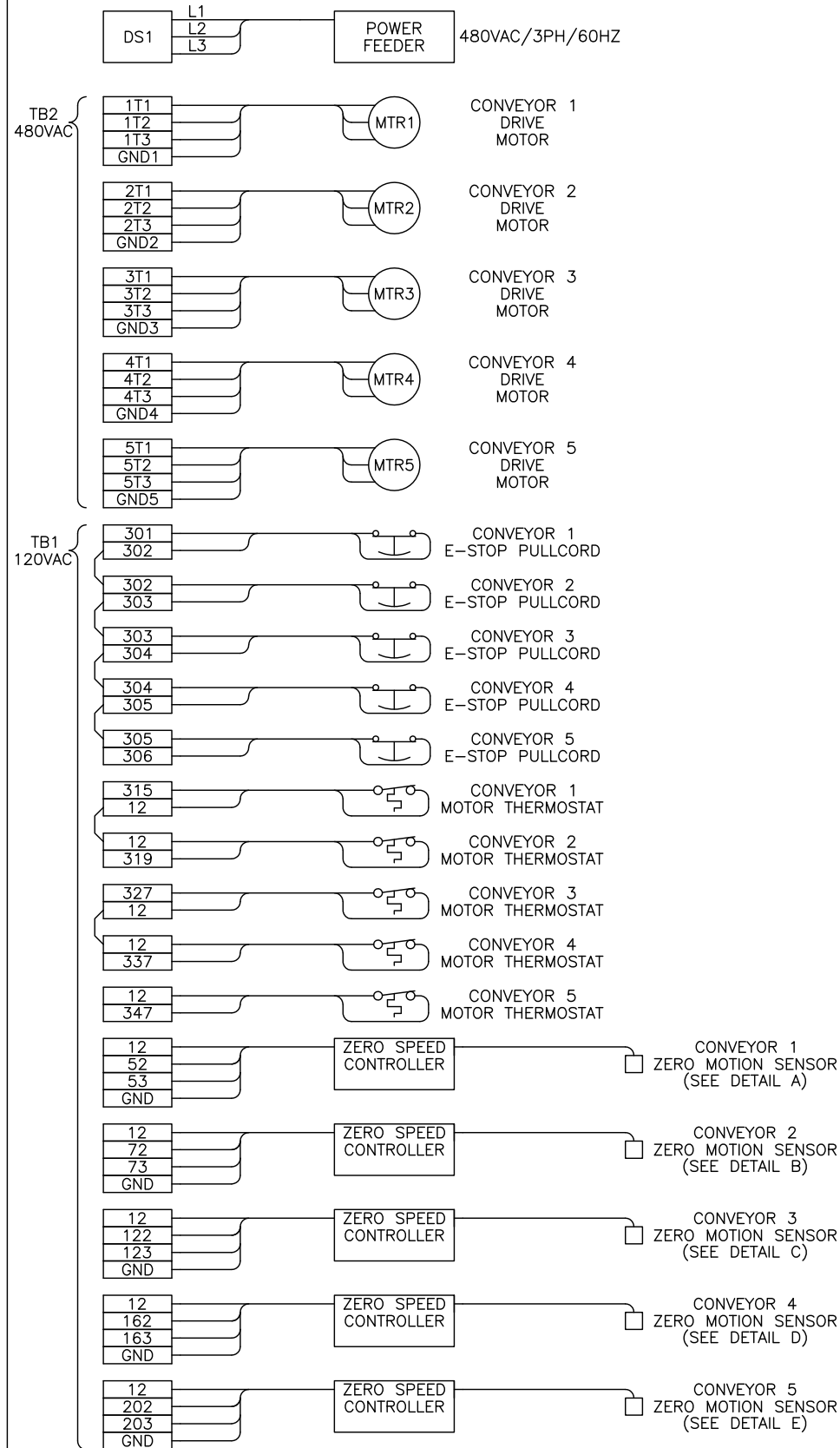
DRAWING NO: HBR9465A11

11 OF 17

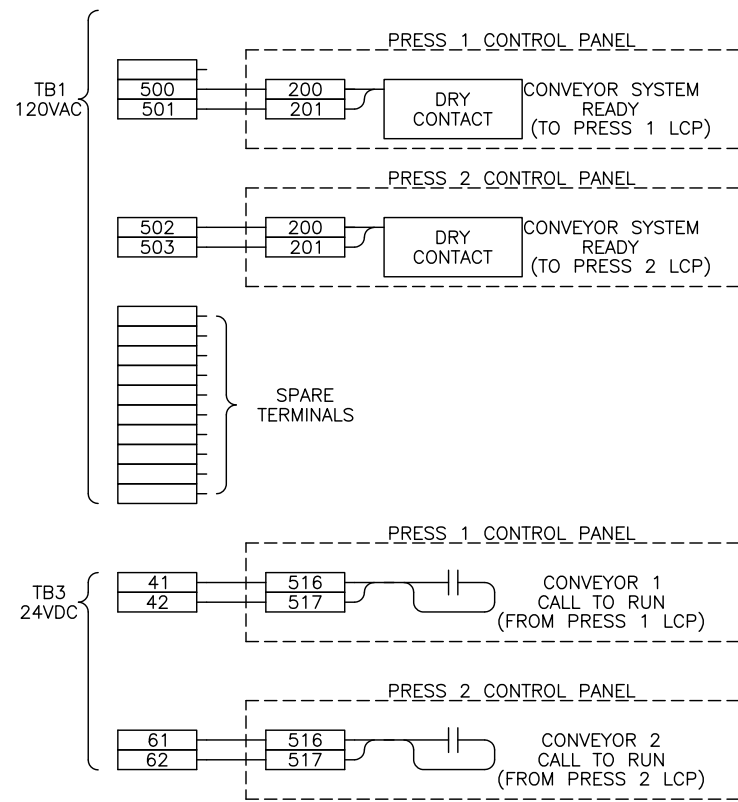
FIELD WIRING DIAGRAM

WARNING DAMAGE RESULTING FROM INSTALLATION OF TOP ENTRY CONDUIT WILL VOID WARRANTY.

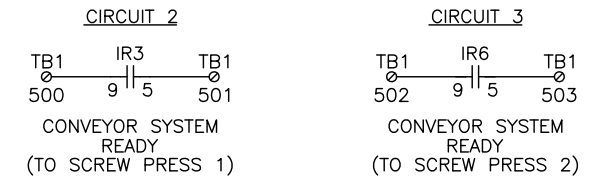
- AVOID CUTTING HOLES DIRECTLY ABOVE ANY ELECTRICAL COMPONENTS
- PROTECT INTERNAL COMPONENTS FROM METAL SHAVINGS, CUTTING OILS, DEBRIS, AND MOISTURE
- USE PROPER FITTINGS, MYERS TYPE 4 OR EQUAL
- CONDUITS AND FITTING MUST BE WATERTIGHT TO PREVENT WATER ENTRY
- ALL PENETRATIONS MUST BE SEALED OFF TO PREVENT INTRUSION OF MOISTURE, CORROSIVE GASES, AND VAPORS FROM ENTERING THE ENCLOSURE



FIELD WIRING DIAGRAM

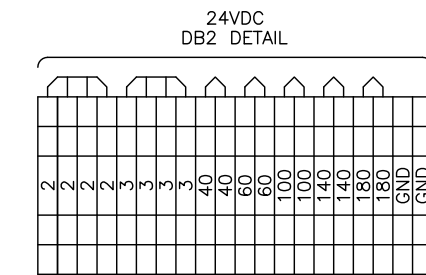
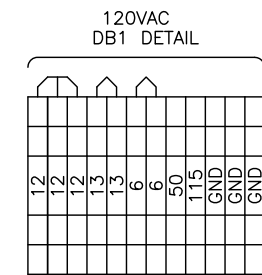


DRY CONTACTS FOR PLANT USE



MAX. CONTROLLED LOAD: 10A @ 120VAC

NOTE: BRANCH CIRCUIT PROTECTION PROVIDED BY OTHERS PER N.E.C.



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CONVEYOR CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9465A12

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PLC/OIU SETTINGS

L306ER CPU	DISCRETE IN	DISCRETE OUT
	QTY: 2 SLOT 1,2	QTY: 1 SLOT 3

PLC INPUTS -- SLOT NO.1

I/0	E-STOP PRESSED
I/1	SYSTEM RESET
I/2	CONVEYOR 1 IN AUTO
I/3	CONVEYOR 1 RUNNING
I/4	CONVEYOR 1 FAULT
I/5	CONVEYOR 1 ZERO MOTION
I/6	CONVEYOR 2 IN AUTO
I/7	CONVEYOR 2 RUNNING
I/8	CONVEYOR 2 FAULT
I/9	CONVEYOR 2 ZERO MOTION
I/10	CONVEYOR 3 IN AUTO
I/11	CONVEYOR 3 RUNNING
I/12	CONVEYOR 3 FAULT
I/13	CONVEYOR 3 ZERO MOTION
I/14	POWER FEED OK
I/15	SPARE

PLC OUTPUTS -- SLOT NO.3

O/0	CONTROL POWER ENABLE
O/1	CONVEYOR 1 FAULT
O/2	CONVEYOR 2 FAULT
O/3	CONVEYOR 3 FAULT
O/4	CONVEYOR 4 FAULT
O/5	CONVEYOR 5 FAULT
O/6	CONVEYOR SYSTEM READY (TO PRESS 1 CP)
O/7	CONVEYOR SYSTEM READY (TO PRESS 2 CP)
O/8	CONVEYOR 3 CALL TO RUN FOR.
O/9	CONVEYOR 3 CALL TO RUN REV.
O/10	CONVEYOR 4 CALL TO RUN FOR.
O/11	CONVEYOR 4 CALL TO RUN REV.
O/12	CONVEYOR 5 CALL TO RUN FOR.
O/13	CONVEYOR 5 CALL TO RUN REV.
O/14	SPARE
O/15	COMMON ALARM

PLC INPUTS -- SLOT NO.2

I/0	CONVEYOR 4 IN AUTO
I/1	CONVEYOR 4 RUNNING
I/2	CONVEYOR 4 FAULT
I/3	CONVEYOR 4 ZERO MOTION
I/4	CONVEYOR 5 IN AUTO
I/5	CONVEYOR 5 RUNNING
I/6	CONVEYOR 5 FAULT
I/7	CONVEYOR 5 ZERO MOTION
I/8	SPARE
I/9	SPARE
I/10	SPARE
I/11	SPARE
I/12	SPARE
I/13	SPARE
I/14	SPARE
I/15	SPARE

PLC/OIU SETTINGS

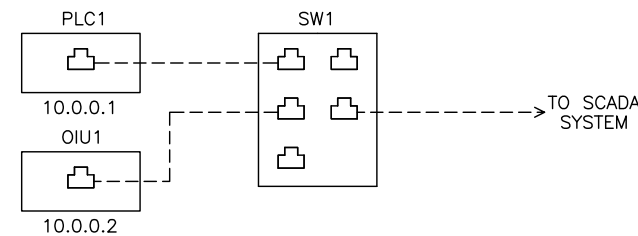
PLC1 -- COMMUNICATIONS SETUP

ETHERNET PORT PARAMETERS	VALUE
IP ADDRESS	10.0.0.1
SUBNET MASK	255.255.255.0
GATEWAY ADDRESS	0.0.0.0
BOOTP ENABLE	NO

OIU1 -- COMMUNICATIONS SETUP

ETHERNET PORT PARAMETERS	VALUE
IP ADDRESS	10.0.0.2
SUBNET MASK	255.255.255.0
GATEWAY ADDRESS	0.0.0.0
BOOTP ENABLE	NO

ETHERNET NETWORK MAP



NOTES:

1. ---- CAT5 ETHERNET CABLE

SUBNET MASK: 255.255.255.0

DEVICE SETTINGS

CM1-5 -- CURRENT MONITOR

DIP SETTINGS	VALUE
1	ON
2	OFF
3	ON
4	OFF
5	OFF
6	ON

DIAL SETTINGS	VALUE
HYSTERESIS	0%
LEVEL	FLA
DELAY	0.5s

WIRE PASSES	MAX AMPS	LEVEL RANGE (10-110%)
1	20	2-22A
2	10	1-11A
3	6.6	0.6-7.3A
4	5	0.5-5.5A

* ABOVE VALUES ASSUME 20A MAX DIP SETTINGS

NOTES:

- FIELD CONFIGURATION SHALL BE PERFORMED BY THE STARTUP TECHNICIAN PER THE APPROPRIATE TECHNICAL DOCUMENTS.
- MEASURING RANGE MAXIMUM AMPS SET BY DIP SETTINGS 1 AND 2
SW1 ON/SW2 OFF = 20A; SW1 ON/SW2 ON = 50A; SW1 OFF/SW2 ON = 100A

HTR1 -- SETTINGS

HEATER ON/OFF	60 °F
---------------	-------

IS1 -- SETTINGS

FAN ON/OFF	60 °F
------------	-------

AL1 -- ALARM LIGHT

SWITCH

1	2
<input checked="" type="checkbox"/>	<input type="checkbox"/>

SINGLE FLASH SETTING
SWITCH 1 = ON
SWITCH 2 = OFF

PFR1 -- SETTINGS

DIAL	SETTING
VOLTAGE	480 ON DELAY
Tt	5s
>U	10%
<U	10%

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CONVEYOR
CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9465A13

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PLC/OIU SETTINGS

PLC/OIU SETTINGS

PLC1 - SETPOINTS

REGISTER	DESCRIPTION	UNITS	DEFAULT	MIN	MAX
SP1 0 .INT	EQUIPMENT STARTUP DELAY	SEC.	3	0	10
SP1 1 .INT	DURATION MODE RUN DURATION	MIN.	900	1	9999
SP1 2 .INT	VOLUME MODE PROCESS VOLUME	GAL	100	1	99999
SP1 3 .INT	DATALOGGER INTERVAL	SEC.	10	1	999
SP1 110 .INT	CONVEYOR 1 OFF DELAY	SEC.	30	0	999
SP1 111 .INT	CONVEYOR 1 ZERO MOTION DELAY	SEC.	10	1	999
SP1 112 .INT	CONVEYOR 1 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 120 .INT	CONVEYOR 2 OFF DELAY	SEC.	30	0	999
SP1 121 .INT	CONVEYOR 2 ZERO MOTION DELAY	SEC.	10	1	999
SP1 122 .INT	CONVEYOR 2 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 130 .INT	CONVEYOR 3 OFF DELAY	SEC.	30	0	999
SP1 131 .INT	CONVEYOR 3 ZERO MOTION DELAY	SEC.	10	1	999
SP1 132 .INT	CONVEYOR 3 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 133 .INT	CONVEYOR 3 DIRECTION CHANGE DWELL	SEC.	5	0	999
SP1 140 .INT	CONVEYOR 4 OFF DELAY	SEC.	30	0	999
SP1 141 .INT	CONVEYOR 4 ZERO MOTION DELAY	SEC.	10	1	999
SP1 142 .INT	CONVEYOR 4 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 143 .INT	CONVEYOR 4 DIRECTION CHANGE DWELL	SEC.	5	0	999
SP1 150 .INT	CONVEYOR 5 OFF DELAY	SEC.	30	0	999
SP1 151 .INT	CONVEYOR 5 ZERO MOTION DELAY	SEC.	10	1	999
SP1 152 .INT	CONVEYOR 5 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 153 .INT	CONVEYOR 5 DIRECTION CHANGE DWELL	SEC.	5	0	999
SP1 160 .INT	DISCHARGE POINT 1 DURATION	MIN.	10	0	9999
SP1 161 .INT	DISCHARGE POINT 2 DURATION	MIN.	10	0	9999
SP1 162 .INT	DISCHARGE POINT 3 DURATION	MIN.	10	0	9999
SP1 163 .INT	DISCHARGE POINT 4 DURATION	MIN.	10	0	9999
SP1 170 .INT	PRESS 1 OFF DELAY	SEC.	30	0	999
SP1 171 .INT	PRESS 1 FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1 172 .INT	PRESS 2 OFF DELAY	SEC.	30	0	999
SP1 173 .INT	PRESS 2 FAIL TO RUN FAULT DELAY	SEC.	10	1	999

PLC1 - SCADA COMMUNICATIONS

REGISTER NUMBER	DESCRIPTION	DATA TYPE	NORMAL STATE	ACTIVE STATE	SCADA FUNCTION
PLC IO STATUS					
S_INT 1	PLC SLOT 1 DISCRETE INPUTS	(BIT)	0	1	READ
S_INT 2	PLC SLOT 2 DISCRETE INPUTS	(BIT)	0	1	READ
S_INT 3	PLC SLOT 3 DISCRETE OUTPUTS	(BIT)	0	1	READ
CONVEYOR 1					
S_INT 14.0	CONVEYOR 1 RUNNING	(BIT)	0	1	READ
S_INT 14.1	CONVEYOR 1 IN AUTO	(BIT)	0	1	READ
S_INT 14.2	CONVEYOR 1 FAULT	(BIT)	0	1	READ
S_INT 14.3	CONVEYOR 1 ZERO SPEED	(BIT)	0	1	READ
CONVEYOR 2					
S_INT 15.0	CONVEYOR 2 RUNNING	(BIT)	0	1	READ
S_INT 15.1	CONVEYOR 2 IN AUTO	(BIT)	0	1	READ
S_INT 15.2	CONVEYOR 2 FAULT	(BIT)	0	1	READ
S_INT 15.3	CONVEYOR 2 ZERO SPEED	(BIT)	0	1	READ
CONVEYOR 3					
S_INT 16.0	CONVEYOR 3 RUNNING	(BIT)	0	1	READ
S_INT 16.1	CONVEYOR 3 IN AUTO	(BIT)	0	1	READ
S_INT 16.2	CONVEYOR 3 FAULT	(BIT)	0	1	READ
S_INT 16.3	CONVEYOR 3 ZERO SPEED	(BIT)	0	1	READ
CONVEYOR 4					
S_INT 17.0	CONVEYOR 4 RUNNING	(BIT)	0	1	READ
S_INT 17.1	CONVEYOR 4 IN AUTO	(BIT)	0	1	READ
S_INT 17.2	CONVEYOR 4 FAULT	(BIT)	0	1	READ
S_INT 17.3	CONVEYOR 4 ZERO SPEED	(BIT)	0	1	READ
CONVEYOR 5					
S_INT 18.0	CONVEYOR 5 RUNNING	(BIT)	0	1	READ
S_INT 18.1	CONVEYOR 5 IN AUTO	(BIT)	0	1	READ
S_INT 18.2	CONVEYOR 5 FAULT	(BIT)	0	1	READ
S_INT 18.3	CONVEYOR 5 ZERO SPEED	(BIT)	0	1	READ
GENERAL					
S_INT 20.0	E-STOP PRESSED	(BIT)	0	1	READ
S_INT 21.1	POWER FEED OK	(BIT)	0	1	READ

DESIGNED	JN
DETAILED	
CHECKED	MSN
APPROVED	
DATE	11/10/23
REVISION	
NO.	
BY	
CK	
APP	
DATE	

HUBER
TECHNOLOGY

1009 Airlie Parkway
Denver, NC 28037
Tel. 704-949-1010
info@hhusa.net

CONVEYOR CONTROL PANEL

MT. CLEMENS, MI SCALE: NONE

PROJECT NUMBER: 73010851 DRAWING NO: HBR9465A14

14 OF 17

SEQUENCE OF OPERATION

CONTROL POWER ON-DELAY:

EACH TIME THE CONTROL PANEL POWER SUPPLY IS CYCLED, THE PLC WILL ALLOW ALL SOLID STATE DEVICES TO FULLY ENERGIZE BEFORE ENABLING THE CONTROL POWER CIRCUIT.

CONVEYOR 1-2 MODES OF OPERATION:

HAND: WHEN THE CONVEYOR SELECTOR IS IN THE HAND POSITION, THE CONVEYOR WILL RUN CONTINUOUSLY

AUTO: WHEN THE CONVEYOR SELECTOR IS IN THE AUTO POSITION, THE CONVEYOR WILL BE CALLED TO RUN WHENEVER THE PRESS IS RUNNING. THE CONVEYOR WILL CONTINUE TO RUN AFTER THE PRESS HAS STOPPED FOR THE TIME SET IN THE CONVEYOR OFF DELAY TIMER SET THROUGH THE OIU.

NOTE: THE SCREW PRESS 1 WILL CALL CONVEYOR 1
THE SCREW PRESS 2 WILL CALL CONVEYOR 2

CONVEYOR 3-5 MODES OF OPERATION:

HAND: WHEN THE CONVEYOR SELECTOR IS IN THE HAND POSITION, THE CONVEYOR WILL RUN CONTINUOUSLY IN THE DIRECTION SELECTED BY THE CONVEYOR FOR-OFF-REV SELECTOR.

AUTO: WHEN THE CONVEYOR SELECTOR IS IN THE AUTO POSITION, THE CONVEYOR WILL RUN PER THE CONVEYOR OPERATION TABLE BELOW ONCE THE PRESS IS RUNNING. THE CONVEYOR DISCHARGE POINT CAN BE SELECTED MANUALLY OR SET TO TIME OPERATION. THIS SELECTION WILL BE MADE FROM THE OPERATOR INTERFACE. ONCE THE PRESS HAS STOPPED, EACH CONVEYOR THAT IS RUNNING WILL CONTINUE TO RUN FOR THE TIME SET IN THE CONVEYOR OFF DELAY TIMER.

MANUAL MODE: WHEN THE MANUAL MODE IS SELECTED FROM THE OPERATOR INTERFACE, THE OPERATOR CAN SELECT WHICH DISCHARGE POINT WILL BE FILLED

TIME MODE: WHEN THE TIMED MODE IS SELECTED FROM THE OPERATOR INTERFACE, THE CONVEYORS WILL FILL EACH DISCHARGE POINT FOR A USER SELECTED TIME. WHEN EVERY POINT HAS BEEN FILLED, THE SYSTEM WILL ENTER THE SHUTDOWN MODE

IN THE AUTO MODE THE CONVEYOR WILL OPERATE PER THE CONVEYOR OPERATION TABLE DETAILED BELOW.

CONVEYOR OPERATION

DISCHARGE POINT	CONVEYOR 3 OPERATION	CONVEYOR 4 OPERATION	CONVEYOR 5 OPERATION
1 (DUMPSTER 1)	FORWARD	REVERSE	OFF
2 (DUMPSTER 1)	FORWARD	FORWARD	OFF
3 (DUMPSTER 2)	REVERSE	OFF	FORWARD
4 (DUMPSTER 2)	REVERSE	OFF	REVERSE

FORCED DISCHARGE:

WHEN THE CONVEYOR ARE IN THE AUTOMATIC MODE, THE OPERATOR CAN SELECT THE FORCE DISCHARGE OPTION TO TOP OFF ANY DISCHARGE POINT. WHEN THE OPTION IS SELECTED THE CONVEYOR WILL DISCHARGE TO THE SELECTED POINT FOR A USER SELECTED TIME. WHEN THE FORCED DISCHARGE IS COMPLETE, THE CONVEYOR WILL RESUME NORMAL OPERATION.

NOTES:

ANY DISCHARGE POINT CAN BE DISABLED FROM THE OIU. WHEN DISABLED THE CONVEYOR WILL NOT DISCHARGE TO THIS POINT IN AUTOMATIC MODE

SEQUENCE OF OPERATION

SYSTEM FAULTS:

1. CONVEYOR MOTOR OVERLOAD DETECTED
2. CONVEYOR HIGH CURRENT DETECTED
3. CONVEYOR RUNNING INDICATION NOT RECEIVED WHILE CALLED TO RUN
4. CONVEYOR ZERO MOTION INDICATION RECEIVED FOR THE TIME SET IN THE CONVEYOR ZERO MOTION DELAY
5. NO CONVEYOR DISCHARGE POINTS ARE AVAILABLE

- WHEN ANY OF FAULTS 1 - 5 OCCUR, THE THE ALARM BEACON WILL ENERGIZE AND THE ENTIRE SYSTEM WILL SHUT DOWN IMMEDIATELY. THE ALARM BEACON WILL REMAIN ENERGIZED UNTIL THE CONDITION IS CORRECTED.

ALARM BEACON:

THE ALARM BEACON WILL ENERGIZE IF ANY OF THE SYSTEM FAULTS OCCUR. THE ALARM BEACON WILL REMAIN ENERGIZED UNTIL THE FAULT IS CLEARED AND THE SYSTEM RESET PUSHBUTTON IS PRESSED.

EMERGENCY STOP:

ALL CONVEYOR EQUIPMENT WILL STOP IMMEDIATELY IF THE E-STOP PUSHBUTTON IS ACTIVATED. THE CONVEYOR SYSTEM WILL NOT RESUME OPERATION UNTIL THE E-STOP IS RESET AND THE SYSTEM RESET PUSHBUTTON IS PRESSED.

OIU - INFORMATION:

1. THE OIU WILL DISPLAY THE ELAPSED MOTOR RUN TIMES.
2. ALL ADJUSTABLE SETPOINTS CAN BE ACCESSED AND ADJUSTED THROUGH THE OIU.
3. THE PRESENT FAULT WILL BE DISPLAYED ON THE OIU.
4. THE HISTORY OF ALL PAST FAULTS CAN BE ACCESSED THROUGH THE OIU.
5. RUNNING AND FAULTED STATUS FOR ALL MOTORS WILL BE DISPLAYED ON THE OIU.
6. THE CONVEYOR DISCHARGE MODE CAN BE SELECTED THROUGH THE OIU.

CONVEYOR SYSTEM READY:

A NORMALLY OPEN, CLOSED WHEN CONVEYOR SYSTEM IS READY SIGNAL WILL BE PROVIDED WHEN THE FOLLOWING CONDITIONS ARE PRESENT:

- ALL E-STOPS READY
- ALL CONVEYOR SELECTOR SWITCHES IN AUTO
- NO EQUIPMENT FAULTS
- DISCHARGE POINTS AVAILABLE

					DESIGNED	JN
					DETAILED	
					CHECKED	MSN
					APPROVED	
DATE	REVISION	NO.	BY	CK	APP	DATE
						11/10/23

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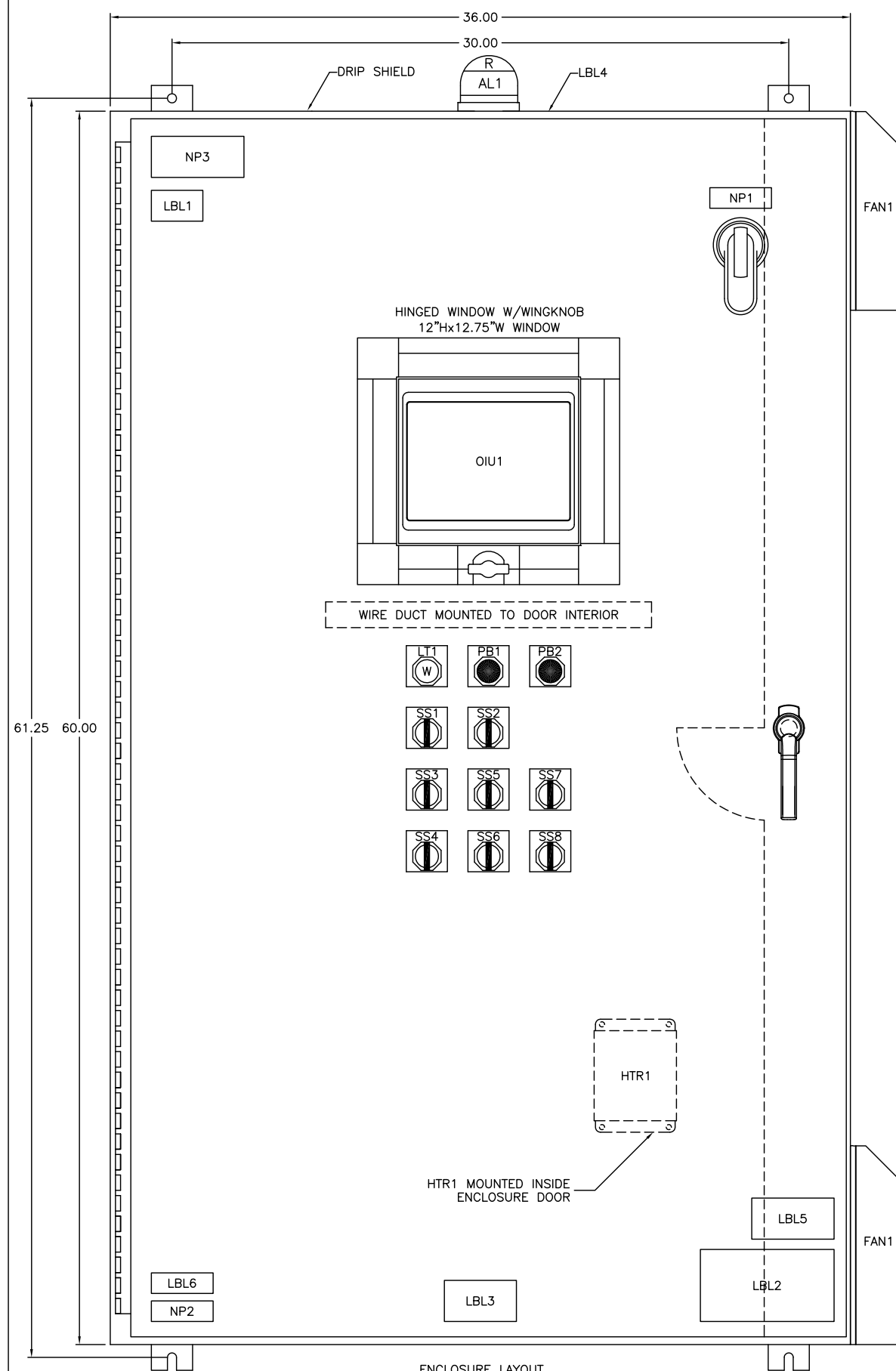
CONVEYOR
CONTROL PANEL

MT. CLEMENS, MI

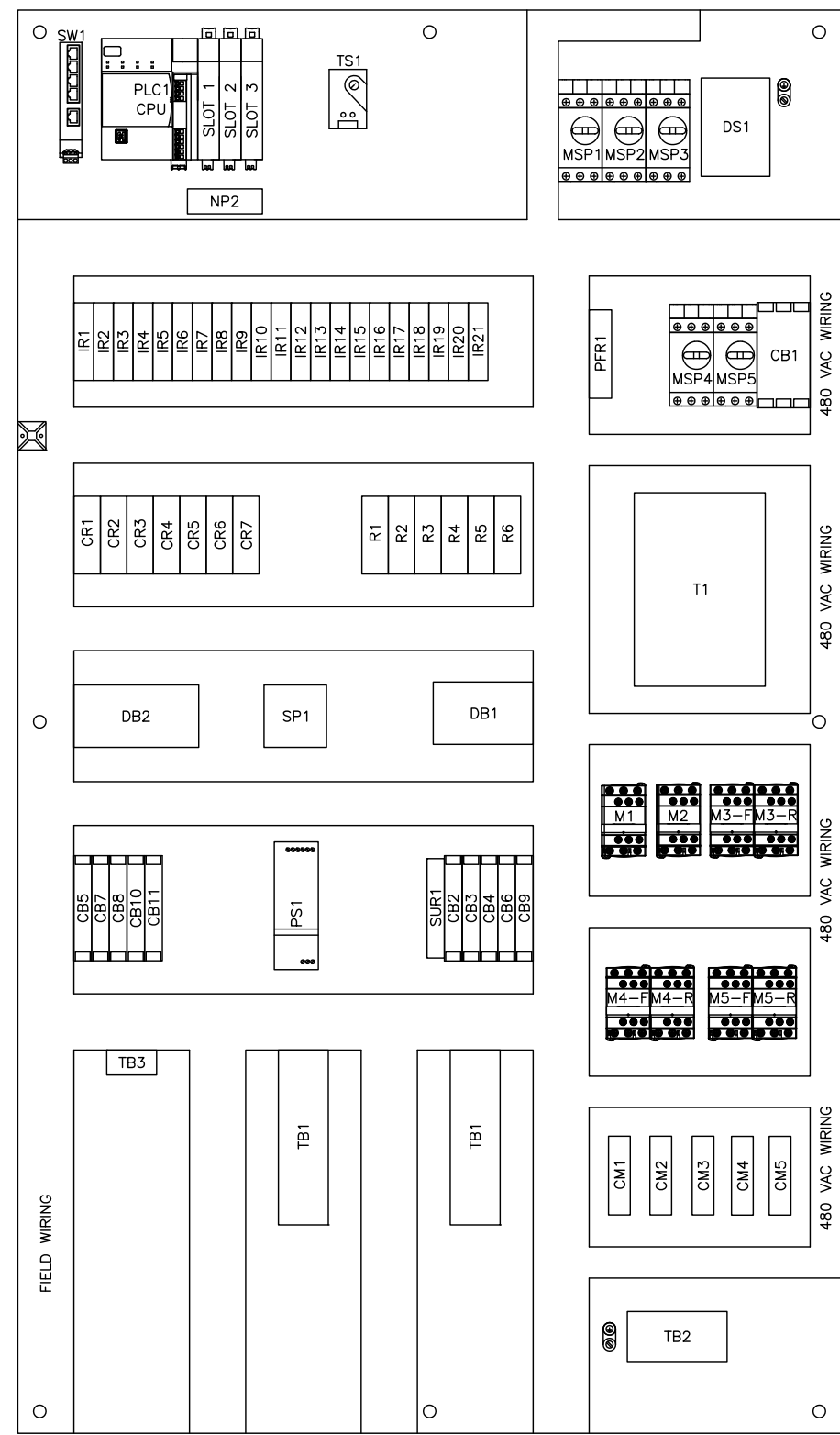
SCALE:
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PROJECT NUMBER:
73010851

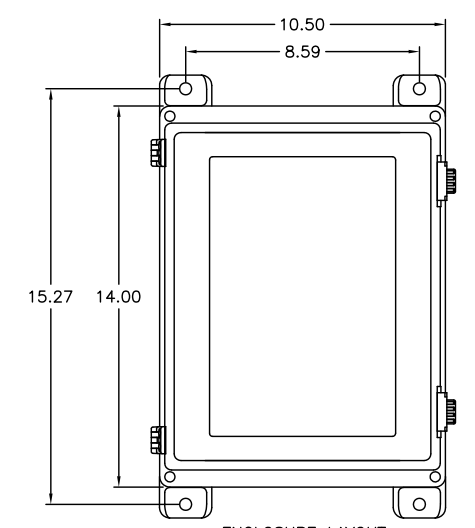
DRAWING NO:
HBR9465A15



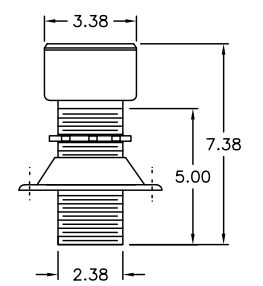
ENCLOSURE LAYOUT
60"Hx36"Wx12"D
NEMA 4X, 304 STAINLESS STEEL



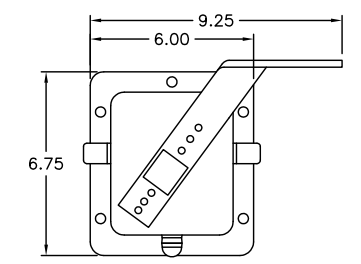
SUB-PANEL LAYOUT
57"Hx33"W



ENCLOSURE LAYOUT
14"Hx12.5"Wx7"D
NEMA 4X FIBERGLASS
10.28"Hx6.84"W WINDOW



ZSS1-5 - ZERO MOTION SENSOR - MSP-12
1/2" NPT FEMALE CONDUIT ENTRANCE (TOP)
2" PHENOLIC PROBE W/MOUNTING FLANGE AND LOCKNUT
GENERAL PURPOSE



PC1-5 - PULL CORD SAFETY SWITCH
6-3/4"Hx6"Wx8-7/16"D
NEMA 4X
CAST ALUMINUM

DATE	REVISION	NO.	BY	CK	APP	DATE

DESIGNED	JN
DETAILED	
CHECKED	MSN
APPROVED	
DATE	11/10/23

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CONVEYOR CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9465A16
16 OF 17	

PILOT DEVICE LEGENDPLATES (PANEL DOOR)				
DEVICE TAG	DESCRIPTOR LINE 1	DESCRIPTOR LINE 2	DESCRIPTOR LINE 3	
LT1	CONTROL POWER	ON		
PB1	EMERGENCY	STOP		
PB2	SYSTEM	RESET		
SS1	CONVEYOR 1	OFF	HAND	AUTO
SS2	CONVEYOR 2	OFF	HAND	AUTO
SS3	CONVEYOR 3	OFF	HAND	AUTO
SS4	CONVEYOR 3	OFF	FOR	REV
SS5	CONVEYOR 4	OFF	HAND	AUTO
SS6	CONVEYOR 4	OFF	FOR	REV
SS7	CONVEYOR 5	OFF	HAND	AUTO
SS8	CONVEYOR 5	OFF	FOR	REV
MAX. CHARACTERS	15	15	4	4

LABEL DESCRIPTION	
LBL1	WARNING MULTIPLE SUPPLY SOURCES OPEN ALL DISCONNECTS BEFORE SERVICING EQUIPMENT OR OTHER UNIT WIRING
LBL2	DANGER HIGH VOLTAGE ENTRY BY QUALIFIED PERSON ONLY
LBL3	ELEMECH ELECTRICAL CONTROL SYSTEMS
LBL4	WARNING DAMAGE RESULTING FROM INSTALLATION OF TOP ENTRY CONDUIT WILL VOID WARRANTY. - AVOID CUTTING HOLES DIRECTLY ABOVE ANY ELECTRICAL COMPONENTS - PROTECT INTERNAL COMPONENTS FROM METAL SHAVINGS, CUTTING OILS, DEBRIS, AND MOISTURE - USE PROPER FITTINGS, MYERS TYPE 4 OR EQUAL - CONDUITS AND FITTING MUST BE WATERTIGHT TO PREVENT WATER ENTRY - ALL PENETRATIONS MUST BE SEALED OFF TO PREVENT INTRUSION OF MOISTURE, CORROSIVE GASES, AND VAPORS FROM ENTERING THE ENCLOSURE
LBL5	DANGER ARC FLASH AND SHOCK HAZARD FOLLOW ALL REQUIREMENTS NFPA 70E FOR SAFE WORK PRACTICES AND FOR PERSONAL PROTECTIVE EQUIPMENT.
LBL6	WARNING TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.

NAMEPLATES			
TAG	DESCRIPTOR LINE 1	DESCRIPTOR LINE 2	DESCRIPTOR LINE 3
NP1	480VAC-3PH-60HZ		
NP2	WARNING! TO AVOID DAMAGING ANY INPUT OR OUTPUT MODULE, VERIFY THE SA POWER REQUIREMENT OF EACH MODULE BEFORE POWER UP. MODULES MUST BE INSTALLED TO THE RIGHT OF THE CORRECT SA POWER SOURCE TO AVOID DAMAGE.		
NP3	ZERO SPEED	CONTROLLER	

NAMEPLATES AND LEGENDPLATES CONSTRUCTION					
	PANEL LEGENDPLATES	LCS LEGENDPLATES	NAMEPLATES	UL698 NAMEPLATES	DEVICE TAGS
TEXT COLOR	BLACK	BLACK	BLACK	BLACK	BLACK
BACKGROUND COLOR	WHITE/ YELLOW (E-STOPS)	WHITE/ YELLOW (E-STOPS)	WHITE	YELLOW	WHITE
MATERIAL	THERMAL TRANSFER	PHENOLIC ENGRAVED	THERMAL TRANSFER	PHENOLIC ENGRAVED	THERMAL TRANSFER
ATTACHMENT	ADHESIVE	ADHESIVE	ADHESIVE	ADHESIVE	ADHESIVE
TEXT SIZE	5/32" HIGH	5/32" HIGH	3/16" HIGH	1/8" HIGH	1/8" HIGH
DIMENSIONS	2.375"x2.375"	1.875"x1.875"	2.72"x1"	4"x2"	1"x1/2"
MAX. CHARACTERS PER LINE	15	15	17	35	7

PANEL DATA LABEL



ELEMECHINC.COM 630-499-7080

WARRANTY NOTICE
NO ALLOWANCE OR PAYMENT WILL BE MADE FOR WARRANTY REPAIR UNLESS PRIOR AUTHORIZATION HAS BEEN REQUESTED AND OBTAINED FROM THE ELEMECH SERVICE DEPT.

SERIAL: HBR9465 POWER: 3/60/480
REF: # 73010851 FLA: 12.6A
DATE: TBD LGST MOT: 2.2A

SHORT CIRCUIT CURRENT RATING
5 KA RMS SYMMETRICAL @ 480 VOLTS MAX

ENCLOSURE RATING: NEMA TYPE 4X

NAME: MT. CLEMENS, MI

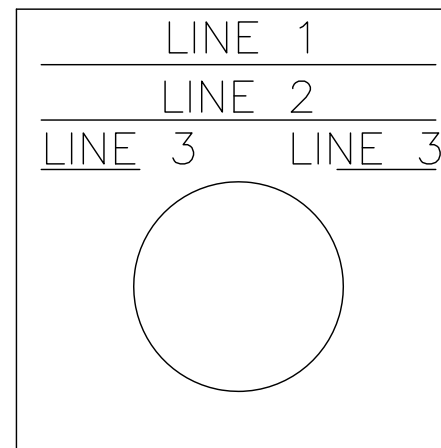
CIRCUIT 2-18: 10A @ 120VAC

TORQUE SCREWS TO 12 IN-LBS

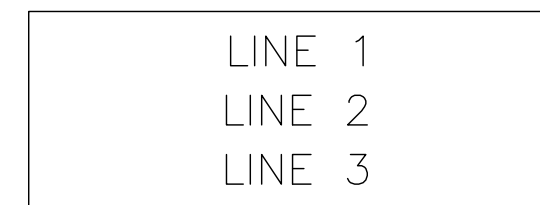
ALL FIELD WIRING SHALL BE 60°C COPPER CONDUCTOR ONLY

NOTE:
THE CONTROL PANEL WILL ALSO BE LISTED AND LABELED WITH A SERIALIZED LABEL AS OUTLINED IN THE CONTROL PANEL SPECIFICATION NOTES.

PILOT DEVICE LEGENDPLATES



PANEL NAMEPLATE



DEVICE TAG



NOTE:
TEXT WILL REMAIN VERTICALLY CENTERED IF LESS THAN 3 LINES ARE USED.

DESIGNED	JN			
DETAILED				
CHECKED	MSN			
APPROVED				
DATE	11/10/23			
REVISION				
NO.	BY	CK	APP	DATE

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1009 Airlie Parkway
Denver, NC 28037
Tel. 704-949-1010
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CONVEYOR CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9465A17

17 OF 17

Bill of Materials



Rev: 0

Date: 11-21-2023

By: JN

Section:

D

Job Number: HBR9465

Page # 1/1

Section Name: Bill of Materials

Item	Component	Description	Manufacturer Part Number	QTY	Device
Conveyor Control Panel (Quantity: 1)					
1	00-000-000	Wire, Hardware, Wire labels, etc.		2	
2	10-069-000	Wireway Duct Cover, 1.5"W, 6 Ft. Section, w/Panduit F Series	Panduit: C1.5WH6	6	
3	10-069-001	Wireway Duct Cover, 1"W, 6 Ft. Section, w/Panduit F Series	Panduit: C1WH6	6	
4	10-069-002	Wireway Duct Cover, 2"W, 6 Ft. Section, w/Panduit F Series	Panduit: C2WH6	9	
5	10-069-005	Wireway Duct, 1.5"Wx3"H, 6 Foot Section	Panduit: F1.5X3WH6	6	
6	10-069-007	Wireway Duct, 1"Wx3"H, 6 Foot Section	Panduit: F1X3WH6	6	
7	10-069-008	Wireway Duct, 2"Wx3"H, 6 Foot Section	Panduit: F2X3WH6	9	
8	25-000-A001	Legendplate Assembly, Yellow E-Stop, Standard Encl.	EleMech: 25-000-A001 Assembly	1	
9	25-000-A002	Legendplate Assembly, White, Black Text, Standard Encl.	EleMech: 25-000-A002 Assembly	10	
10	25-000-A019	Nameplate Assembly, White: Power Supply - 3/60/480VAC	EleMech: 25-000-A019 Assembly	1	
11	42-063-007	Terminal Block, Din Rail, 35MM Wide, 15 High, 2 Meters Long	Iboco: Omega 3 AF	2	
12	51-000-062	Wire, MTW Type, 600V, 105°C, CSA/UL1015, Tinned Copper	EleMech: 51-000-062	1	
13	52-000-003	Label, Underwriters Laboratories 698A, w/Decal Set	EleMech: 698A	1	
14	56-097-005	Beacon, Steady/Strobe, LED, NEMA 4X, 24VDC, Red, 1/2"Male -NS	Federal: LP22LED-012-024R	1	AL1
15	03-058-153	Circuit Breaker, 3 Pole, 480VAC, 8A, 10kA, UL489, Type D	Square D: M9F43308	1	CB1
16	03-058-125	Circuit Breaker, 1 Pole, 240VAC, 10A, 14kA, UL489, Type C	Square D: M9F42110	1	CB2
17	03-058-123	Circuit Breaker, 1 Pole, 240VAC, 6A, 14kA, UL489, Type C	Square D: M9F42106	2	CB3,4
18	03-058-119	Circuit Breaker, 1 Pole, 240VAC, 2A, 14kA, UL489, Type C	Square D: M9F42102	7	CB5-11
19	57-000-A030	Cable, Comm., Ethernet, CAT5e, 600V, RJ45M to RJ45M,Shielded	EleMech: 57-000-A030	2	CBL1,2
20	04-094-000	Current Monitor, Selectable, SPDT, 120/24V ,2-100A, w/Delay	Gavazzi: DIB01CM24100A	5	CM1-5
21	06-058-012	Control Relay, Bus Jumper, 2-Pole, w/Telemec. RXM Relay	Square D: RXZ S2	6	CR1-7
22	06-058-015	Control Relay, 3PDT,24VDC, 11Pin Spade, Indicator, Operator	Square D: RXM3AB2BD	7	CR1-7
23	38-058-003	Socket, 11 Pin Spade, Din, Screw Term., 3Tier, 250V w/3-Pole	Square D: RXZE2S111M	7	CR1-7
24	07-063-000	Distribution Block, End Cover, 4 Pole, 300V,10A, w/WK4E\U\VB	Wieland: 07.311.4053.1	2	DB
25	07-063-001	Distribution Block, Jumper, 4 Pole, 300V,10A, w/WK4E\U\VB	Wieland: Z7.210.3427	7	DB
26	07-063-002	Distribution Block, Single Pole, 10A, 300V, WK4E\U\VB	Wieland: 57.404.6955.1	27	DB
27	09-001-A030	Disconnect Assembly, Non-Fused, 60 Amp, NEMA 4X, 12" Depth	ABB: OT60F3 Assembly	1	DS1
28	11-000-340	Enclosure Drip Shield, Stainless Steel, Per Inch	EleMech: 11-000-340	36	EN1
29	11-000-A042	Wind Kit, Alum/Hinge, Wing Knob w/out Frame, 12.75"H x 12"W	EleMech: 11-000-A042	1	EN1

Item	Component	Description	Manufacturer Part Number	QTY	Device
30	11-035-143	Sub-Panel, Painted Steel, w/60"Hx36"W C. Hinge Encl	Hoffman: A-60P36	1	EN1
31	11-035-451	Enclosure, Nema 4X, 304SS, 60"Hx36"Wx12"D, C. Hinge, 3-PT	Hoffman: A-60H3612SSLP3PT	1	EN1
32	11-182-010	Enclosure Filter Fan, 39CFM w/Filter, 115VAC, NEMA 12, 6"	Rittal: 3238110	1	FAN1
33	11-182-011	Enclosure Filter Fan Hoseproof hood, NEMA 4X, w/ 3238 series	Rittal: 3238080	2	FAN1
34	11-182-012	Enclosure Filter Fan, Outlet Filter	Rittal: 3238200	1	FAN1
35	15-011-000	Ground Lug, 14AWG - 4AWG	Blackburn: L70	2	GND
36	17-035-002	Heater, 100 Watts, 120VAC, w/Thermostat and Fan	Hoffman: D-AH1001A	1	HTR1
37	25-000-A012	Nameplate Assembly, White: Caution Heater Element May Be Hot	EleMech: 25-000-A012 Assembly	1	HTR1
38	06-058-027	Control Relay Retension Clip, w/Telemec. RPM 1-Pole Relay	Square D: RPZR235	21	IR1-21
39	06-058-028	Control Relay, SPDT, 24VDC, 5Pin Spade, Operator, 15A	Square D: RPM12BD	21	IR1-21
40	06-058-040	Diode, 6-250VDC, w/ RXM Sockets, RPZF1/2 Sockets	Square D: RXM040W	21	IR1-21
41	38-058-009	Socket, 5 Pin Spade, Din Mount, Screw Term., w/ RPM 1-Pole	Square D: RPZF1	21	IR1-21
42	52-137-002	Label, Multiple Supply Sources, Warning, 2.5"Wx1.5"H, Yellow	Nameplate Tech: 52-137-002	1	LBL1
43	52-137-001	Label, High Voltage, Danger, 6.5"Wx3.5"H, White/Black/Red	Nameplate Tech: 52-137-001	1	LBL2
44	32-005-A005	Pilot light, NEMA 4X, Universal, LED, White	Allen-Bradley: 800H-QRH2W	1	LT1
45	22-058-002	Contact, 3PH, Non-Rev., 9 Amp, 1NO/1NC Aux., 120VAC Coil	Square D: LC1D09G7	2	M1,2
46	22-058-004	Aux. Contact, Top mounted, 2NO, w/Square D LC/T0 Series	Square D: LADN20	8	M1-5
47	22-058-003	Contact, 3PH, Reversing, 9 Amp, 1NO/1NC Aux., 120VAC Coil	Square D: LC2D09G7	3	M3-5-F/R
48	23-058-003	Motor Starter Protector, Aux., 1NO-1NC, F-Mnt, w/GV2/3	Square D: GVAE11	5	MSP1-5
49	23-058-007	Motor Starter Protector, 3PH, 600V, 1.6-2.5 Amp Range, 508E	Square D: GV2P07	5	MSP1-5
50	23-058-011	Motor Starter Protector, Line Insulator, 508E	Square D: GV2GH7	5	MSP1-5
51	25-000-A010	Nameplate Assembly, White, Black Text, 1"Hx3"W	EleMech: 25-000-A010 Assembly	4	NP1-4
52	26-005-088	OIU, PVP 7 Standard, 7" Display, 24VDC, Touch, Ethernet	Allen Bradley: 2711P-T7C21D8S	1	OIU1
53	HBR-170-P022	Program, OIU, PVP 7 6/7", Standard w/cplgx	EleMech: HBR-170-P022	1	OIU1
54	29-005-117	Pushbutton, E-Stop, NEMA 4X, Oper+1NC, Twist Rel. Red Head	Allen-Bradley: 800H-TFRXT6D2	1	PB1
55	02-005-002	Contact Block, 2NC, w/A-B 800 Series	Allen-Bradley: 800T-XA4	1	PB2
56	29-005-002	Pushbutton, NEMA 4X, Oper+1NO, Flush Head, Black	Allen-Bradley: 800H-AR2D1	1	PB2
57	30-183-000	Phase Failure, Voltage Monitoring Relay, 380-480VAC, 2 SPDT	Telemecanique: RM22TR33	1	PFR1
58	33-005-277	Compact 5069, Discrete Out., (16) 120AC/24DC Relay, 24VDC SA	Allen-Bradley: 5069-OW16	1	PLC1
59	33-005-280	Compact 5069, Term Block, 18 Pin, Screw Clamp, w/ I/O	Allen-Bradley: 5069-RTB18-SCREW	3	PLC1

Item	Component	Description	Manufacturer Part Number	QTY	Device
60	33-005-282	Compact 5069, Term. Block, 6 Pin/4 Pin, Screw Clamp, w/CPU	Allen-Bradley: 5069-RTB64-SCREW	1	PLC1
61	33-005-336	Compact 5069, CPU 0.6MB Mem, SD, 2-Ether, 8 Cards, 24VDC	Allen-Bradley: 5069-L306ER	1	PLC1
62	33-005-347	Compact 5069, Discrete Input , (16) 24VDC Inputs, 24V SA	Allen-Bradley: 5069-IB16	2	PLC1
63	HBR-00-P014	Program, PLC, CompactLogix	EleMech: HBR-00-P014	1	PLC1
64	37-098-018	Power Supply, 240W, 85-264VAC IN, 24VDC OUT, UNO Series	Phoenix: 1096432	1	PS1
65	06-058-021	Control Relay, DPDT,120VAC, 8Pin Spade, Operator, 15A	Square D: RPM22F7	6	R1-6
66	38-058-008	Socket, 8 Pin Spade, Din Mount, Screw Term., w/ RPM 2-Pole	Square D: RPZF2	6	R1-6
67	13-000-A000	Spare Parts Box Assembly, Din Rail Mount	EleMech: 13-000-A000 Assembly	1	SP1
68	39-005-009	Selector Switch, NEMA 4X, 3 Pos. Maintained, 1NO-1NC	Allen-Bradley: 800H-JR2A	5	SS1-8
69	02-005-000	Contact Block, 1NO/1NC, w/A-B 800 Series	Allen-Bradley: 800T-XA	3	SS3,5,7
70	39-005-011	Selector Switch, Nema 4X, 3 Pos. Spring Fr. Right, 1NO-1NC	Allen-Bradley: 800H-JR5A	3	SS4,6,8
71	40-030-002	Surge Suppressor, 1 Pole, 120VAC, 200kA SCCR, DIN	Mersen: STP120P07	1	SUR1
72	33-098-028	Ethernet Switch, 5TX, 9-32VDC, RJ45, 5 Port, 10/100, Narrow	Phoenix: 1085039	1	SW1
73	41-018-028	Control Transformer, Secondary Fuse Cover, w/C Series	Cutler-Hammer: FSK6	1	T1
74	41-018-038	Control Transformer, 480/240-120VAC, 750VA, 1PH	Cutler-Hammer: C0750E2A	1	T1
75	42-063-001	Terminal Block, End Plate, Gray, w/WK4/U	Wieland: 07.311.0155.0	10	TB
76	42-063-015	Terminal Block, Jumper, w/WK4/U, 02 pole, Insulated	Wieland: Z7.281.1227	9	TB
77	42-063-000	Terminal Block, Labels, Custom Printed, w/WK4/U	Wieland: 04.242.6353-CUSTOM	222	TB,DB
78	42-063-004	Terminal Block, Ground, 30A, 600V, 6MM Wide, w/WK4/U	Wieland: 57.504.9055.0	10	TB,DB
79	42-063-009	Terminal Block, End Clamp, w/WKN10/U	Wieland: Z5.522.8553	14	TB,DB
80	42-063-008	Terminal Block, Labels, Blank, w/WK4/U-(600 tags per box)	Wieland: Z4.242.6353	24	TB1
81	42-063-003	Terminal Block, Single Pole Gray, 30A, 600V, 6MM Wide, WK4/U	Wieland: 57.504.0055.0	79	TB1-3
82	46-034-004	Thermostat, for fan control, N.O.contact, 6 amp,30-140 F.	Stego: 11101.9-00	1	TS1
Zero Motion Assembly, Milltronics MFA-4P, Nema 4X FRP (Quantity: 5)					
83	11-035-126	Sub-Panel, Painted Steel, w/12"Hx10"W Junction Box	Hoffman: A-12P10	1	EN
84	11-035-176	Enclosure Mounting Feet, Fiberglass, J box	Hoffman: A-50MFKR	1	EN
85	11-035-273	Enclosure, Nema 4X, Fiberglass, 13.53"Hx10"Wx7"D, w/Window	Hoffman: A-14107JFGQRPWR	1	EN
86	25-000-A010	Nameplate Assembly, White, Black Text, 1"Hx3"W	EleMech: 25-000-A010 Assembly	1	NP
87	65-043-001	Zero Motion Sensor, 120VAC, 2-SPDT Relays, 4X, Probe Req'd	Milltronics: MFA-4P (7MH71441AA2)	1	ZSC
Safety Switch, L/R, 2 SPDT, NEMA 4X, w/fitting, Cable, Plug (Quantity: 5)					

Item	Component	Description	Manufacturer Part Number	QTY	Device
88	92-295-002	Safety Cable, End Fitting	Control Components Company: RS-28	2	PC1
89	92-295-003	Safety Switch, Conduit Plug, 3/4"	Control Components Company: RS-29	3	PC1
90	92-295-007	Safety Switch, Left/Right, NEMA 4X, 3 - 3/4"NPT, Flag Arm	Control Components Company: RS-2	1	PC1
91	92-295-011	Safety Cable, Vinyl Coated, 3/16" O.D., Orange, per ft	Control Components Company: RS-25-105	60	PC1
Spare Parts / Ship Loose (Total Quantity Provided)					
92	65-043-007	Zero Motion Sensor, Probe, Non-Hazardous, w/ MFA-4P	Milltronics: MSP-12 (7MH71460EA)	5	ZSS
93	61-000-012	Labor, Engineering, Submittal, Schematics, BOM	EleMech: 61-000-012	1	ENG

Electrical Drawings



Rev: 0

Date: 11-21-2023

By: JN

Section:

C

Job Number: HBR9464

Page # 1/1

Section Name: Electrical Drawings

MT. CLEMENS, MI	
HBR9464	
SPECIFICATION	Q-PRESS CONTROL PANEL
REFERENCE	73010851

TABLE OF CONTENTS	
DESCRIPTION	DRAWING SHEET NO.
COVER PAGE	HBR9464A01
CONTROL PANEL SPECIFICATION	HBR9464A02
ELECTRICAL SCHEMATICS	HBR9464A03
FIELD WIRING DIAGRAM	HBR9464A10
PLC IO & DEVICE SETPOINTS	HBR9464A11
SEQUENCE OF OPERATION	HBR9464A14
ENCLOSURE LAYOUT	HBR9464A16
NAMEPLATE AND LABEL SCHEDULE	HBR9464A17
PNEUMATIC PANEL	HBR9464B01

					DESIGNED	JN
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Tel. 704-949-1010
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Q-PRESS CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9464A01
1 OF 17	

Control Panel Enclosure

Rating:	NEMA TYPE 4X
Material:	304 SS
Disconnect Type:	Door Interlock - Non-Fused
<input checked="" type="checkbox"/> Drip Shield	<input checked="" type="checkbox"/> 3-PT Latch
<input type="checkbox"/>	<input type="checkbox"/>
Installation Conditions:	
<input checked="" type="checkbox"/> Indoor - Unconditioned	<input type="checkbox"/> Indoor - Conditioned
<input type="checkbox"/> Outdoor - Direct Sunlight	<input type="checkbox"/> Outdoor - Shaded
Environment Max Temperature Rating (°F):	108
Internal Device Max Temperature Rating (°F):	122
Climate Control Type:	NEMA 4X Filter Fan

Panel Construction

Certification:	UL698A
Listing Serial Number:	TBD
Options:	
<input checked="" type="checkbox"/> Phase Failure Relay	<input checked="" type="checkbox"/> Alarm Beacon
<input type="checkbox"/>	<input type="checkbox"/>
Nameplates and Legendplates:	
Material Type:	Thermal Printed
Attachment Type:	Adhesive
Colors:	Background: White Text: Black
Wire/ Cable Type:	Wire Color:
Wiring to be 14 AWG unless otherwise specified. 16 AWG minimum. Wire shall be MTW type, tinned copper, 600VAC, 105°C, UL1015/CSA.	Black - Power Black - 120VAC Hot White - 120VAC Neutral Red - 120VAC Control Yellow - Foreign Voltage Green - Ground Blue - DC Positive White/Blue - DC Negative
Analog signal wiring shall be 18 AWG shielded twisted pair rated 300V.	Wire Labels:
Ethernet cables shall be 24AWG rated 600V. Cat5E.	<input checked="" type="checkbox"/> Adhesive, Self-laminating <input type="checkbox"/> Heat Shrink
Fiber cables shall be SC-Duplex, 50µm multimode.	Note: Colors based on UL508A requirements.

Local Enclosure

Tag:	Pneumatic Panel	Rating:	NEMA 4X	Material:	Fiberglass
------	-----------------	---------	---------	-----------	------------

Power and Motor

Power Feed:					
Circuit 1 :	480	VAC	9.2	FLA	SCCR 5 KAIC @ 480 VAC
Motor Data:					
Motor 1 :	480	VAC	7.1A	FLA	5.36 HP Controller: VFD
Motor 2 :	480	VAC	0.46A	FLA	0.12 HP Controller: FVR

Networking

Communication Type:		Ethernet/ IP
Subnet:	255.255.255.0	Gateway: 0.0.0.0
IP Address:		
PLC1:	To Be Determined - Provide (2) Address	
OIU1:	To Be Determined - Provide (2) Address	
VFD1:	To Be Determined - Provide (2) Address	
Programming:		
PLC1:	CompactLogix 5069-L306ER	Software: Studio 5000 Version: Latest
OIU:	PanclView Plus 7"	Software: FactoryTalk View ME Version: Latest
Notes:		
1. PLC shall be programmed with ladder type only.		
2. HMI shall be developed using EleMech's standard Global Object Library.		

Instrumentation

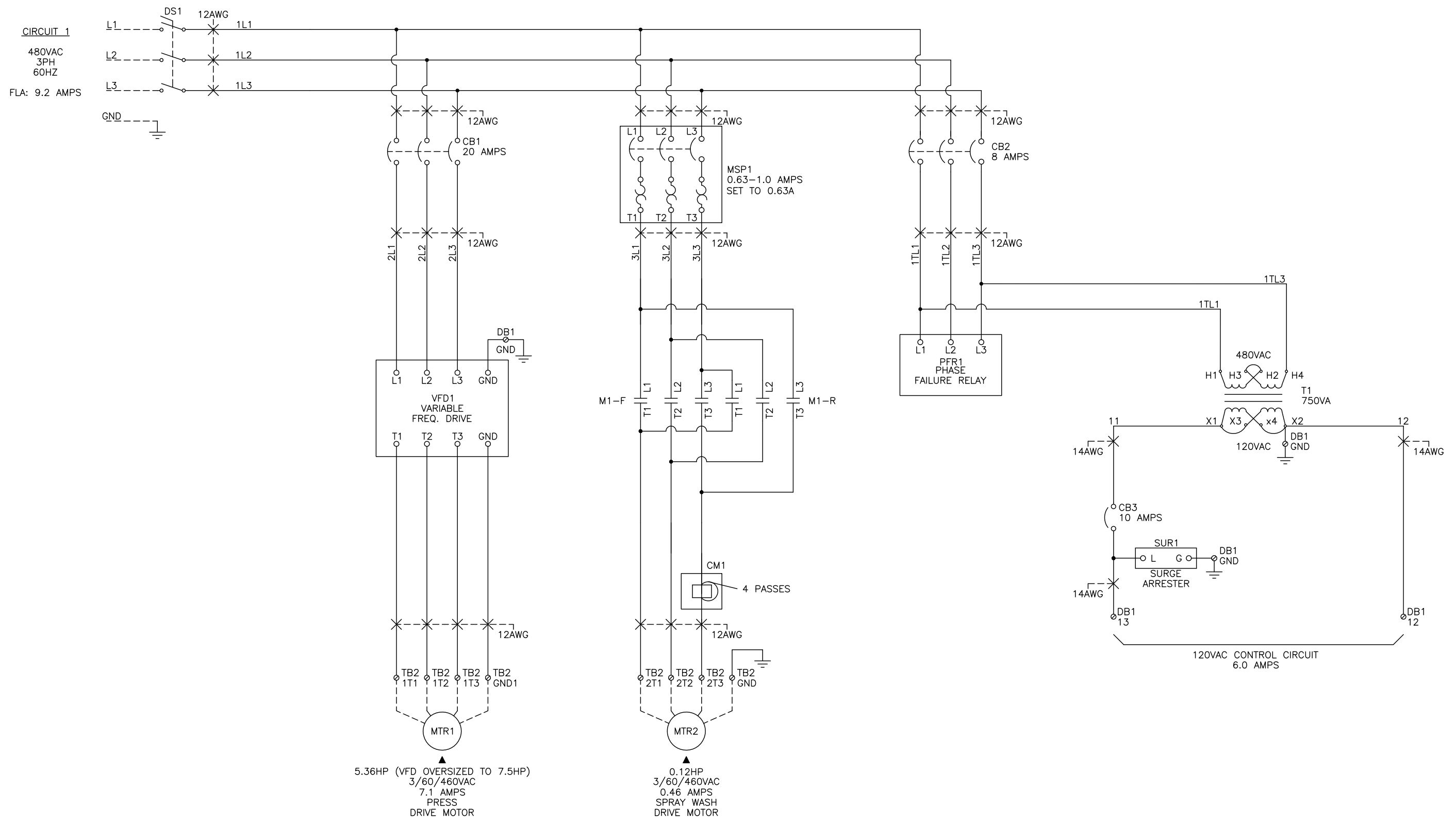
Tag:	N/A	Cable Length:	N/A
Rating:	<input type="checkbox"/> Non-Hazardous	<input type="checkbox"/> Intrinsically Safe Class 1 Division 1,2	
	<input type="checkbox"/> Class 1, Division 2	<input type="checkbox"/> Class 1 Division 1,2	

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Q-PRESS CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9464A02
2 OF 17	



NOTES:

- ▲ DEVICES LOCATED OUTSIDE CONTROL PANEL.
- ⊙ TERMINAL BLOCK (TB) OR DISTRIBUTION BLOCK (DB) LOCATED IN CONTROL PANEL.
- FIELD WIRING.
- ELEMECH RESERVES THE RIGHT TO CHANGE, AS NECESSARY, THE SPACING, ORIENTATION, AND PHYSICAL LOCATION OF DEVICES IN ORDER TO OPTIMIZE THE DESIGN.
- LOCAL MOTOR DISCONNECT SWITCHES SHALL BE PROVIDED BY OTHERS IF REQUIRED BY LOCAL REGULATIONS.
- JUNCTION BOXES ARE NOT SHOWN AND SHALL BE PROVIDED BY OTHERS AS NECESSARY.
- CONTROL DRAWINGS ARE TYPICAL OF (2) CONTROL PANELS.

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Q-PRESS
 CONTROL PANEL

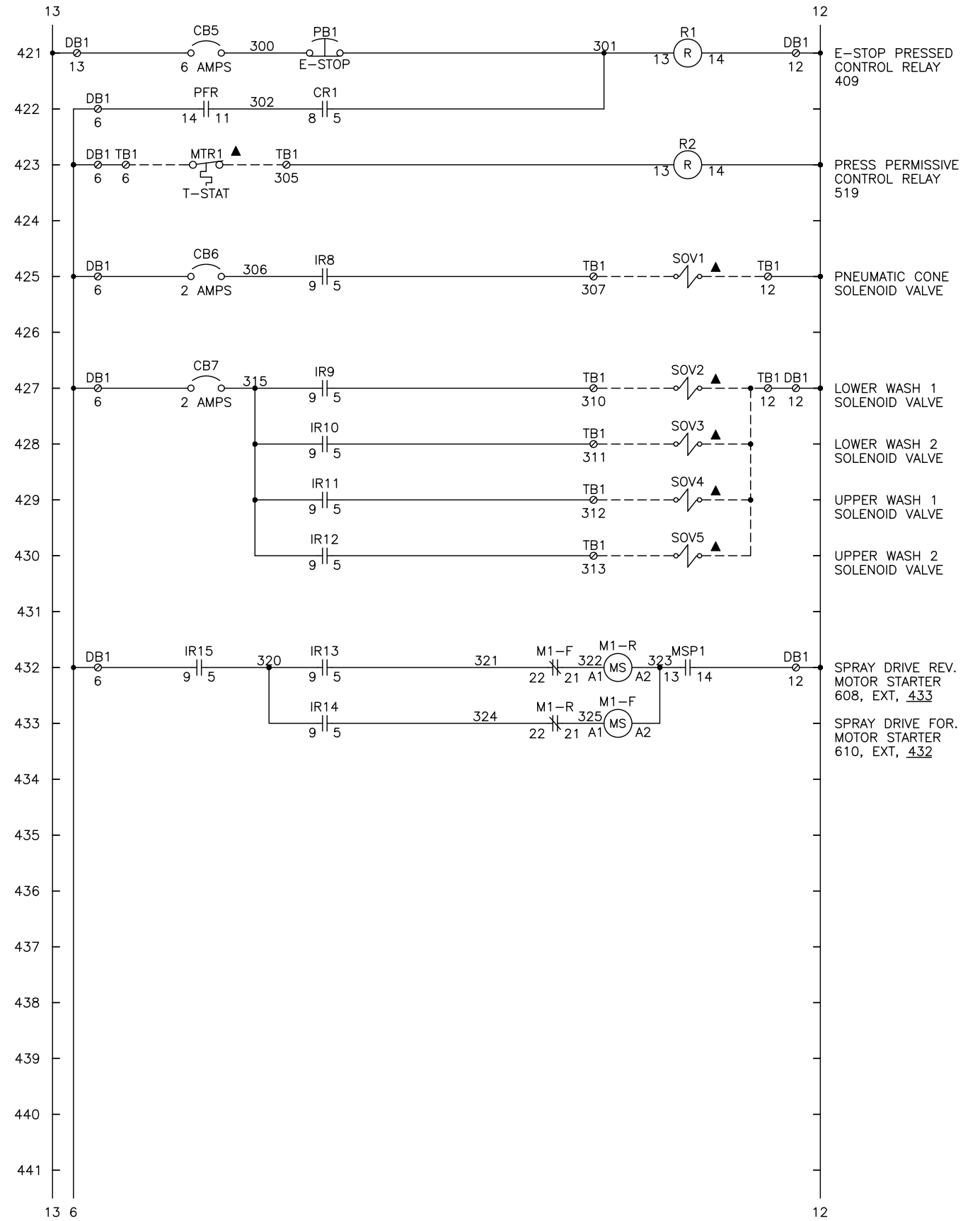
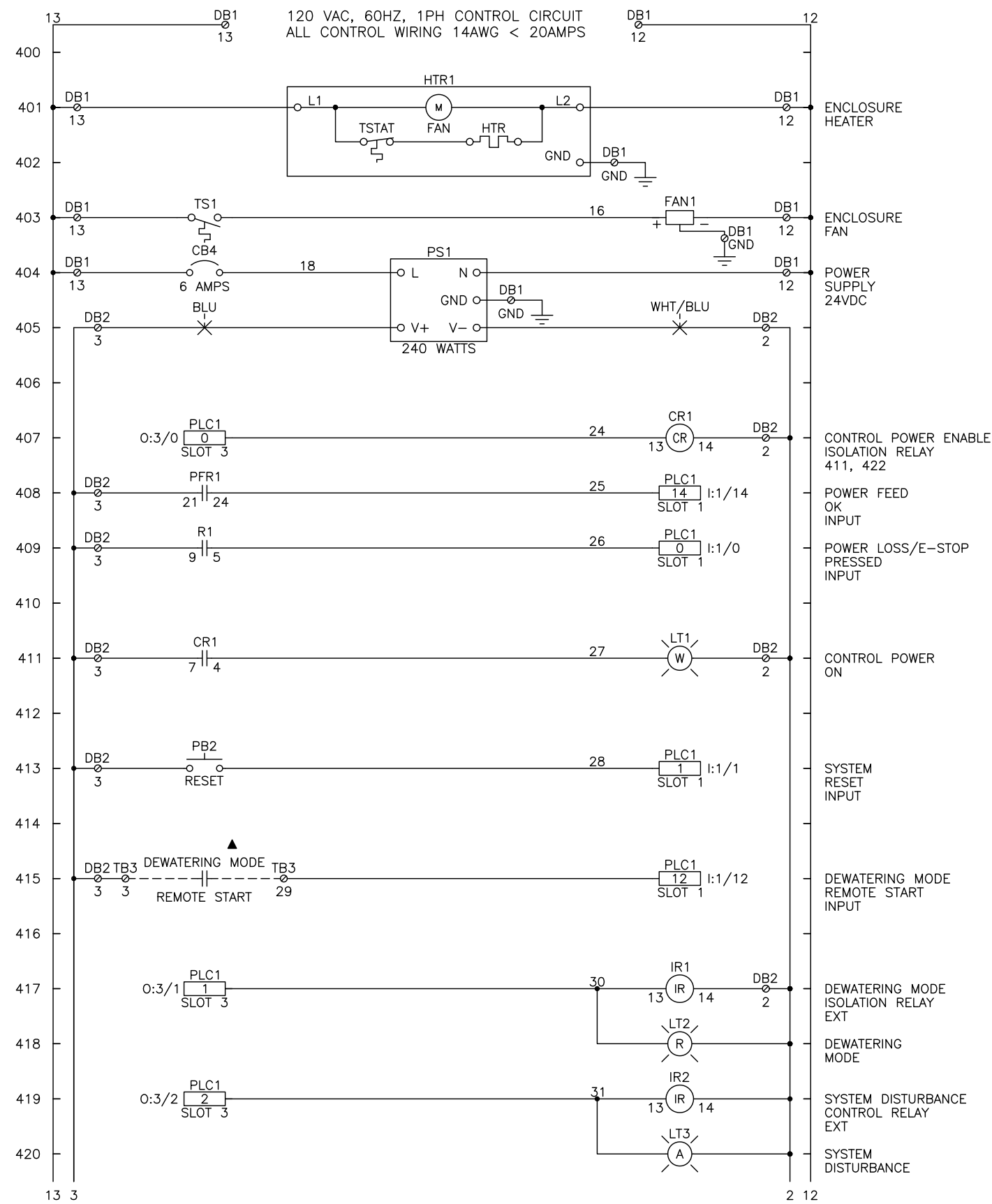
MT. CLEMENS, MI

SCALE:
 NONE

PROJECT NUMBER:
 73010851

DRAWING NO:
 HBR9464A03

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Q-PRESS
CONTROL PANEL

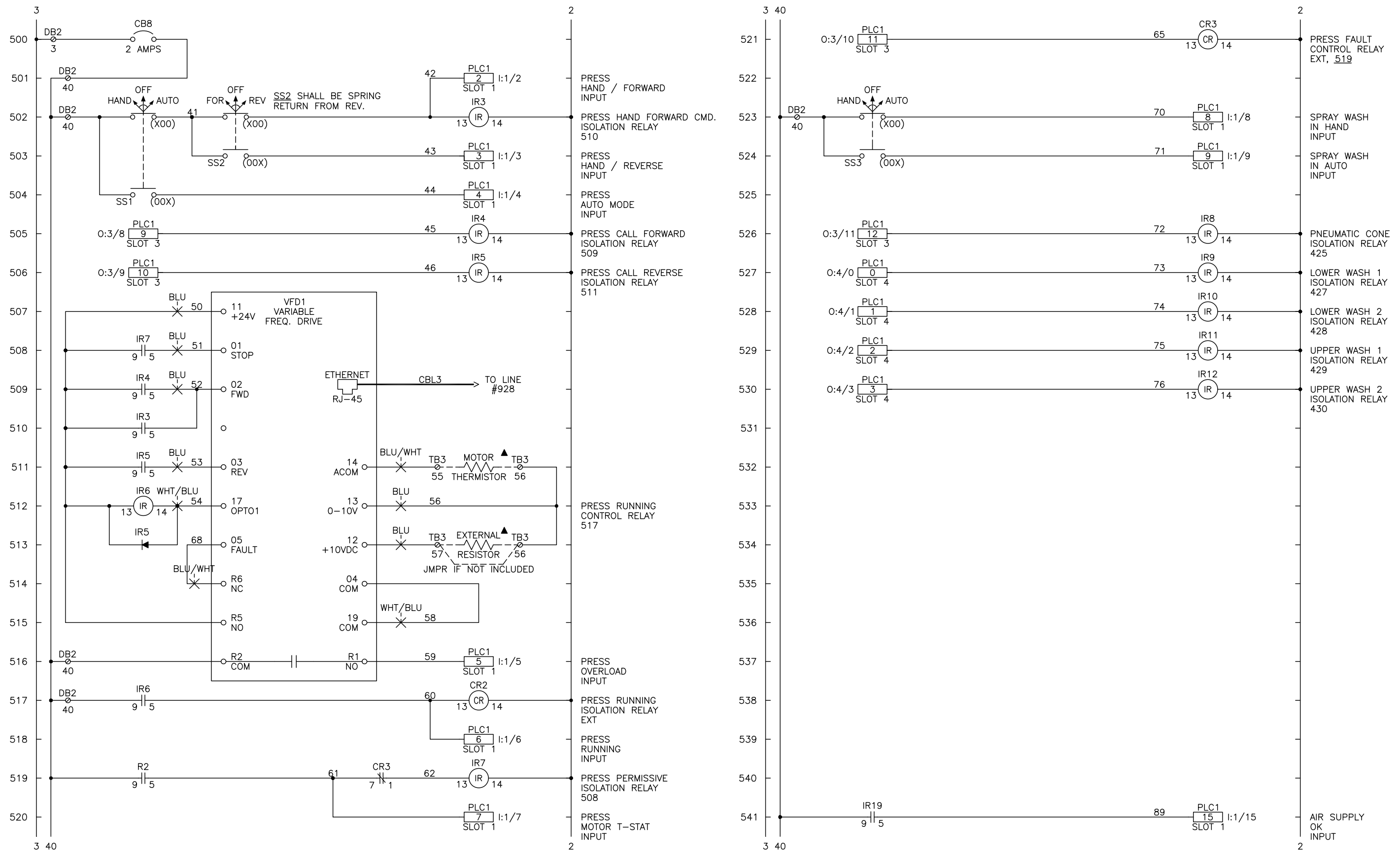
MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9464A04

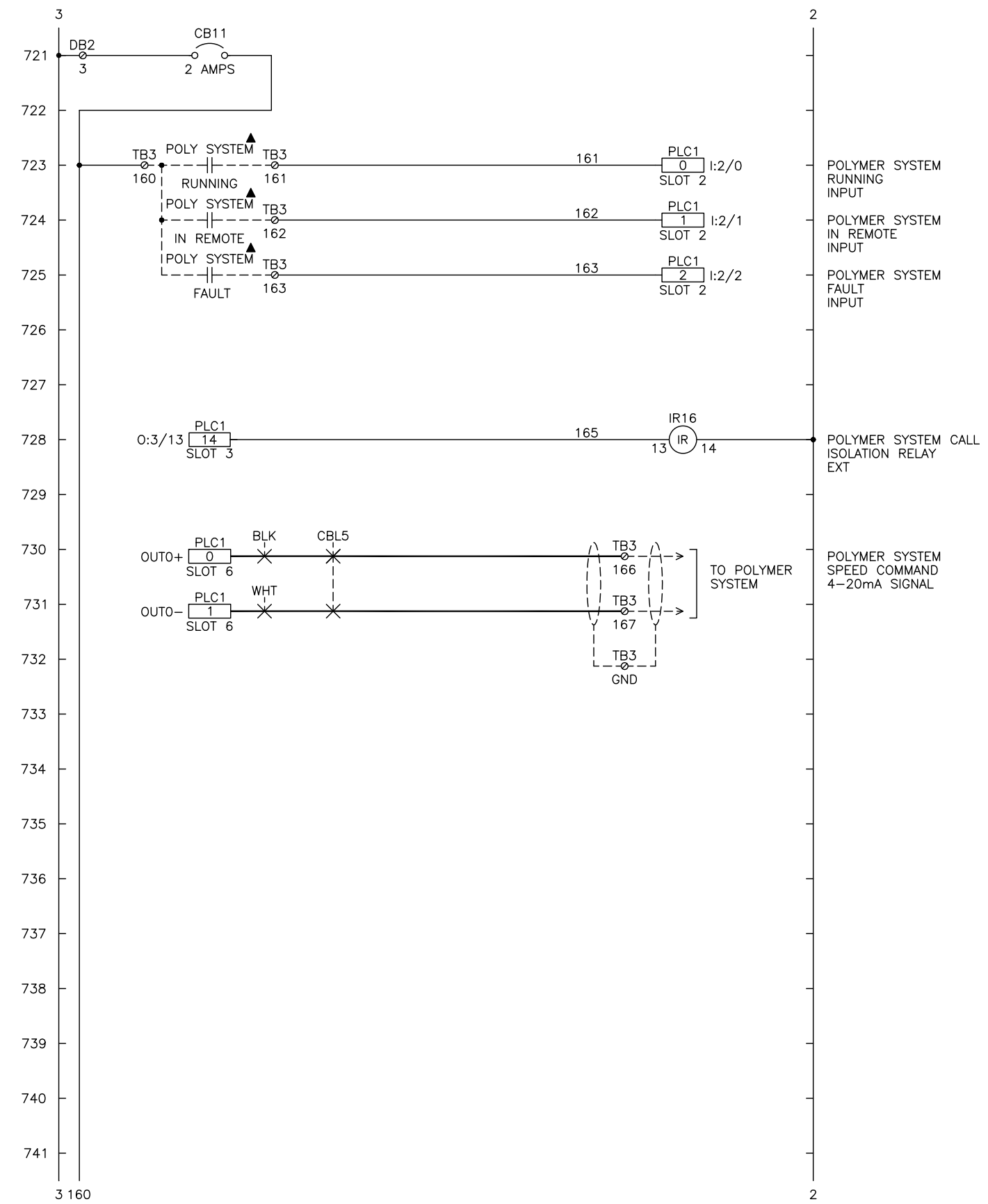
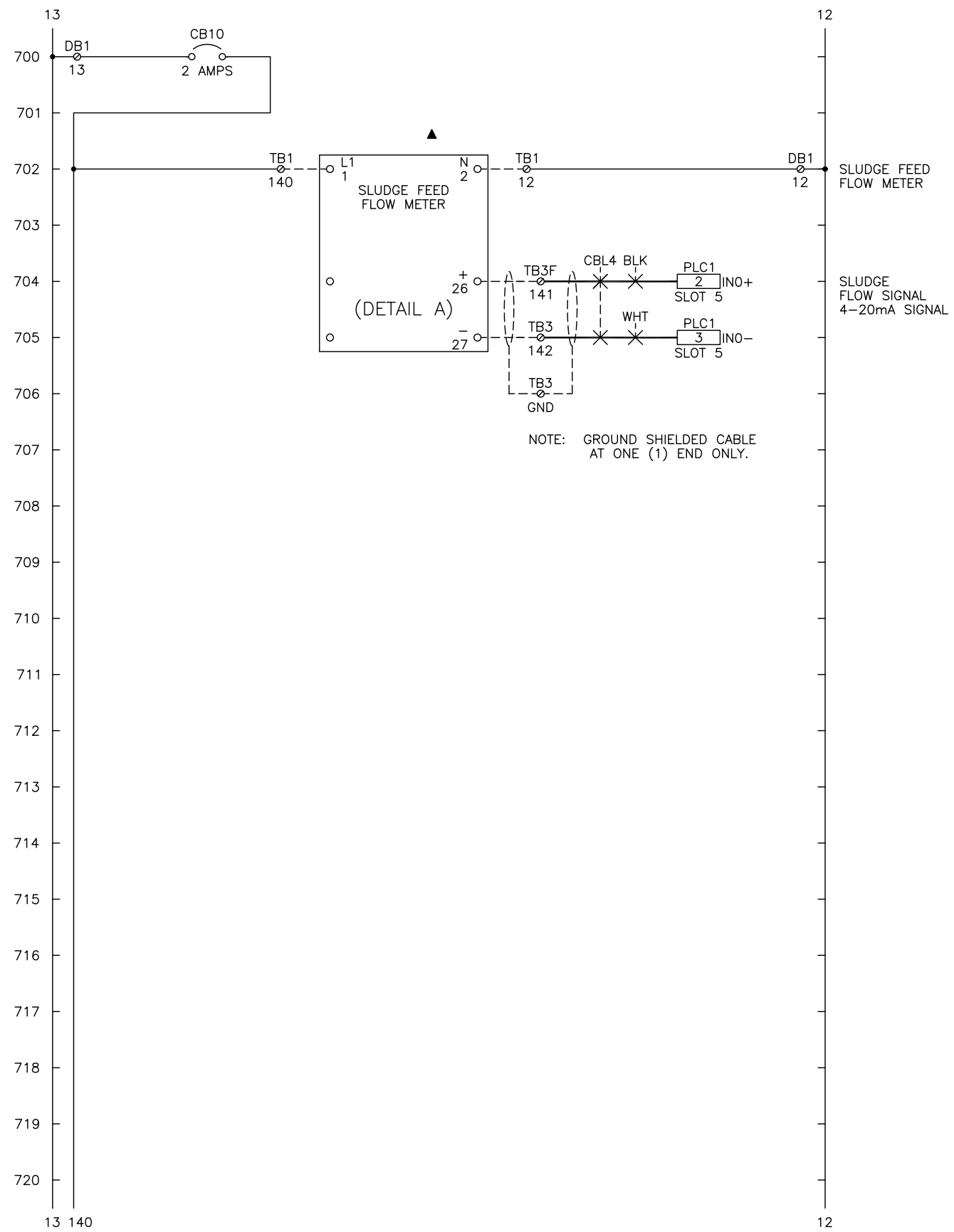
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Q-PRESS
CONTROL PANEL
MT. CLEMENS, MI
SCALE: NONE
PROJECT NUMBER: 73010851
DRAWING NO: HBR9464A05
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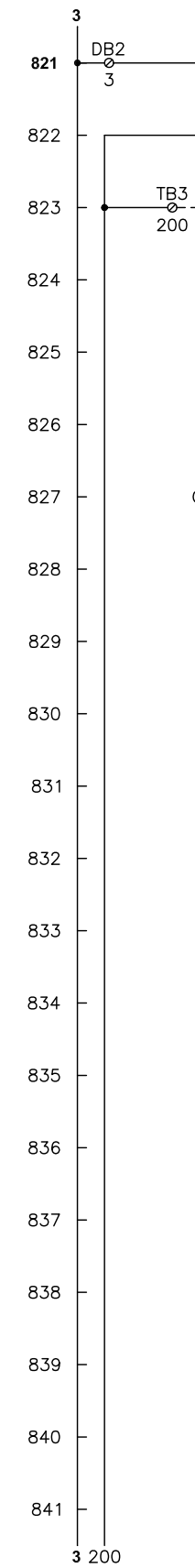
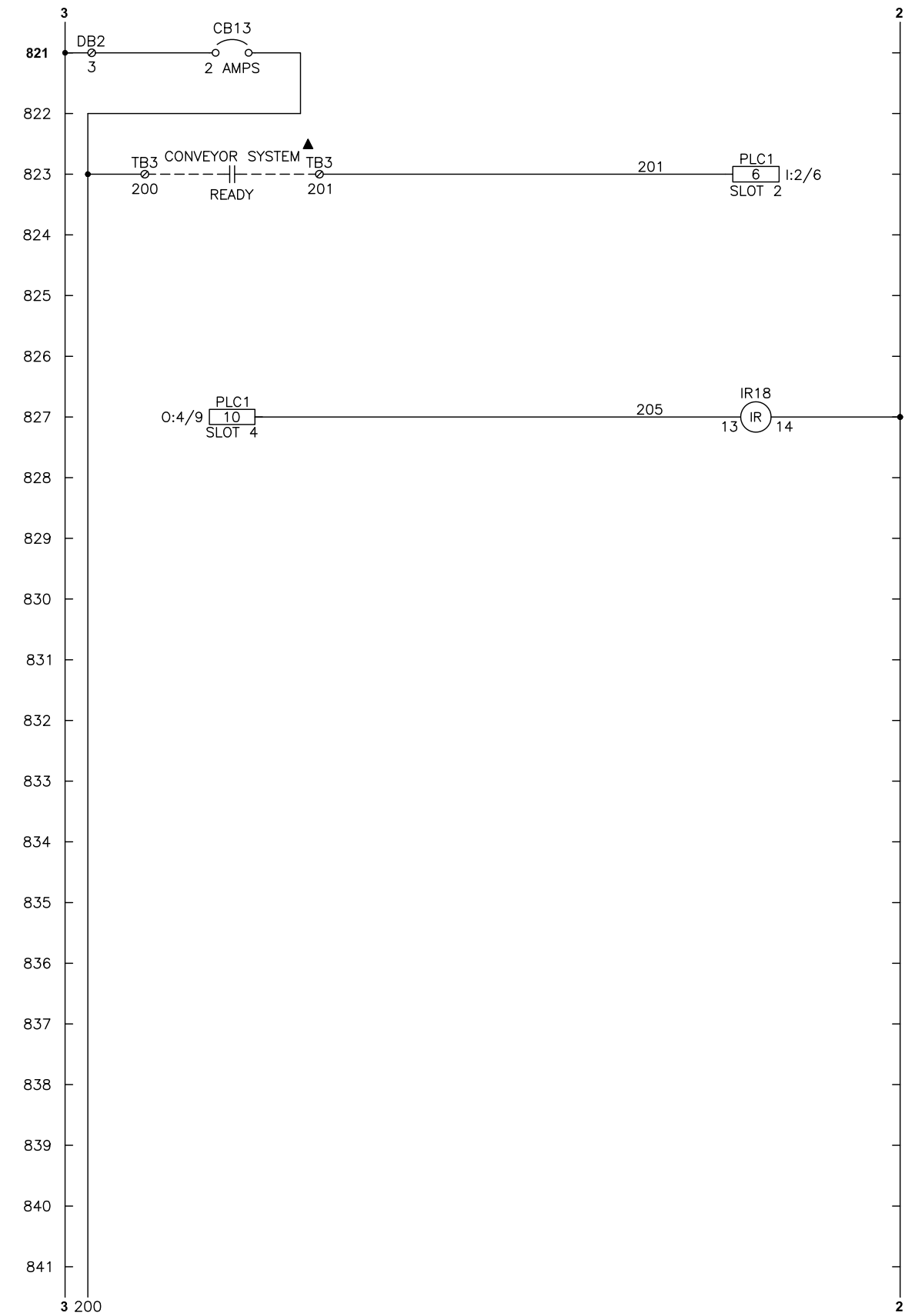
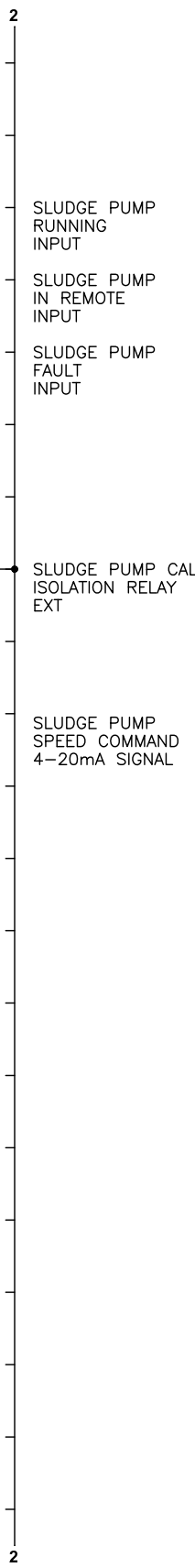
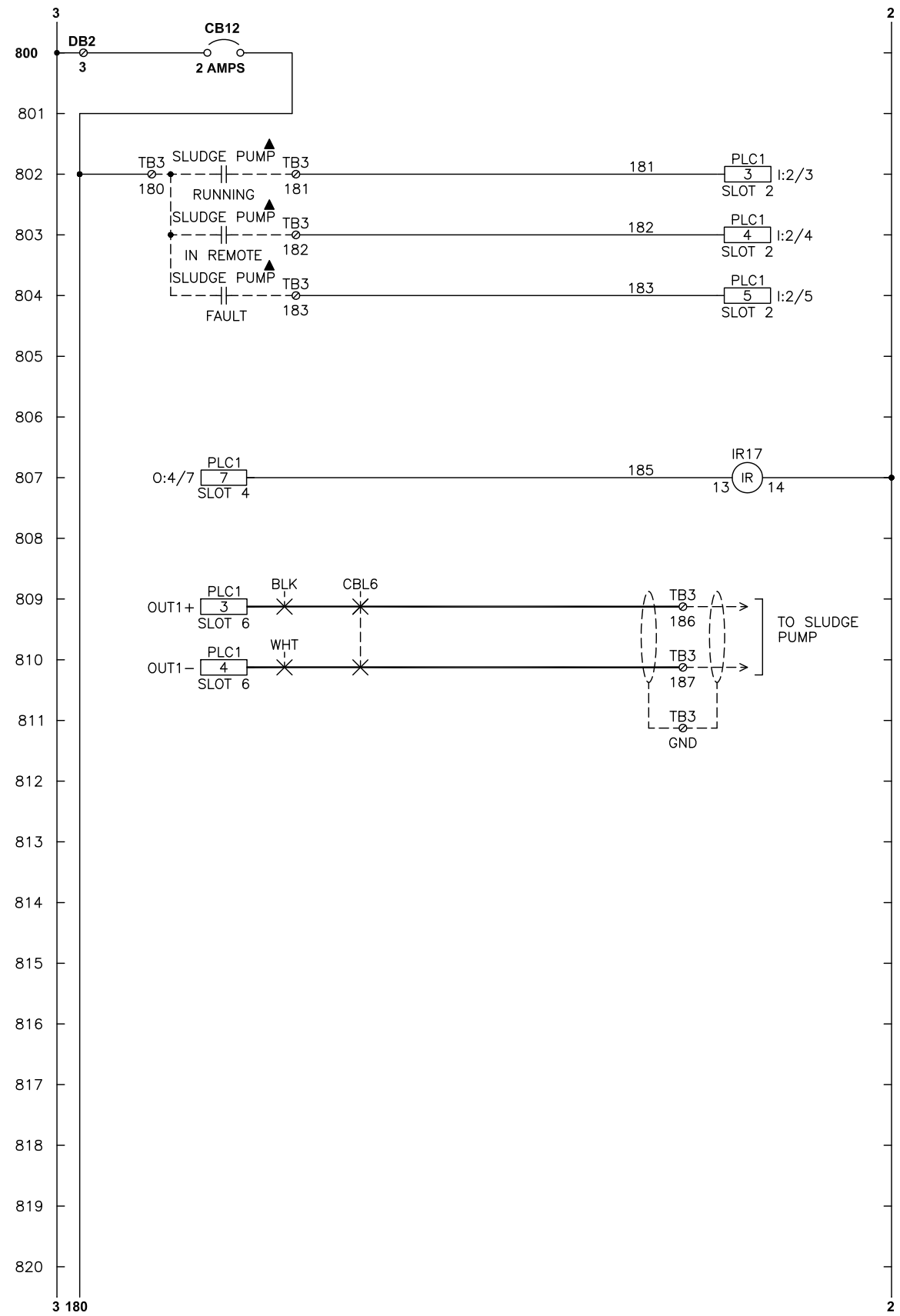
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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI SCALE: NONE

PROJECT NUMBER: 73010851 DRAWING NO: HBR9464A07

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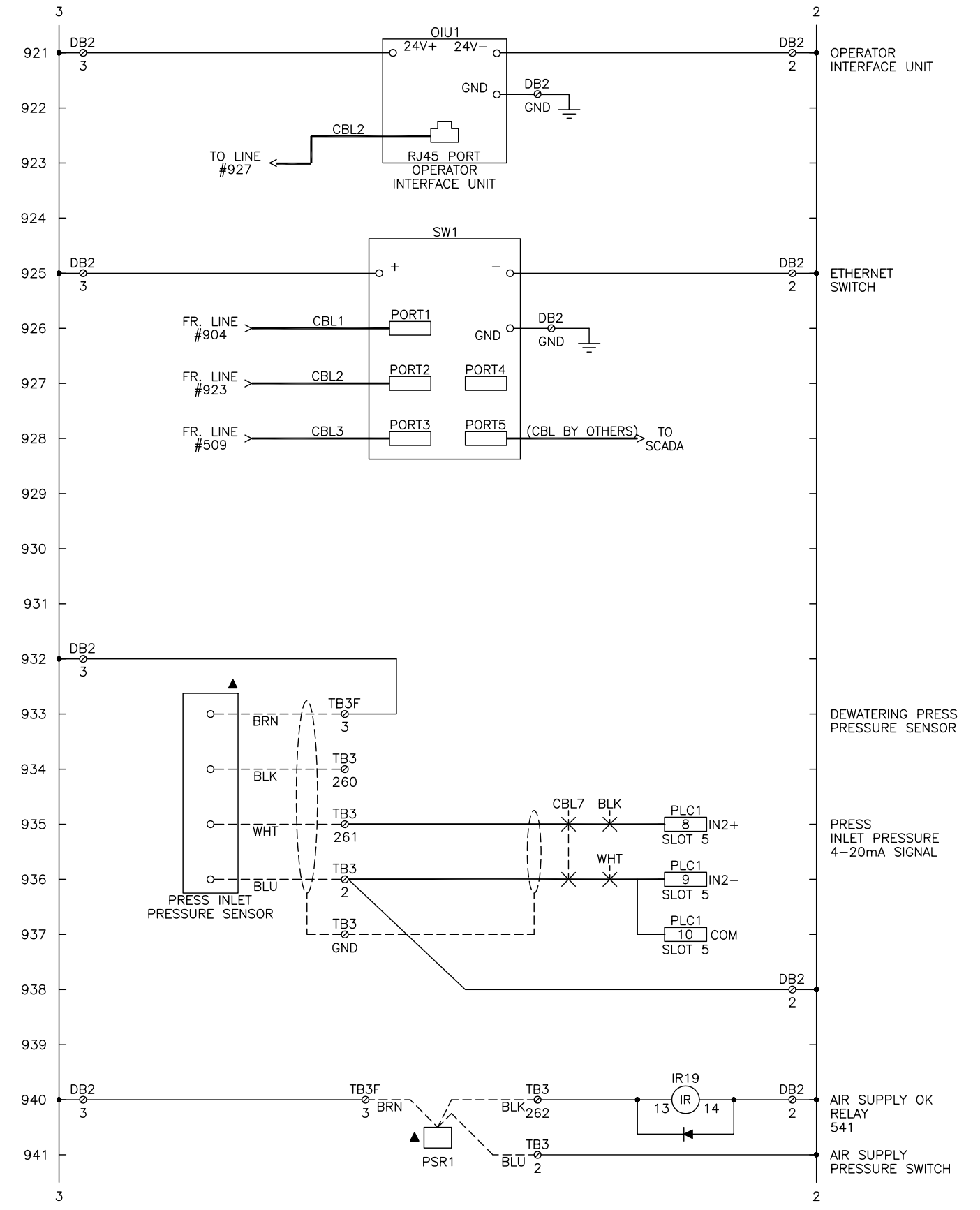
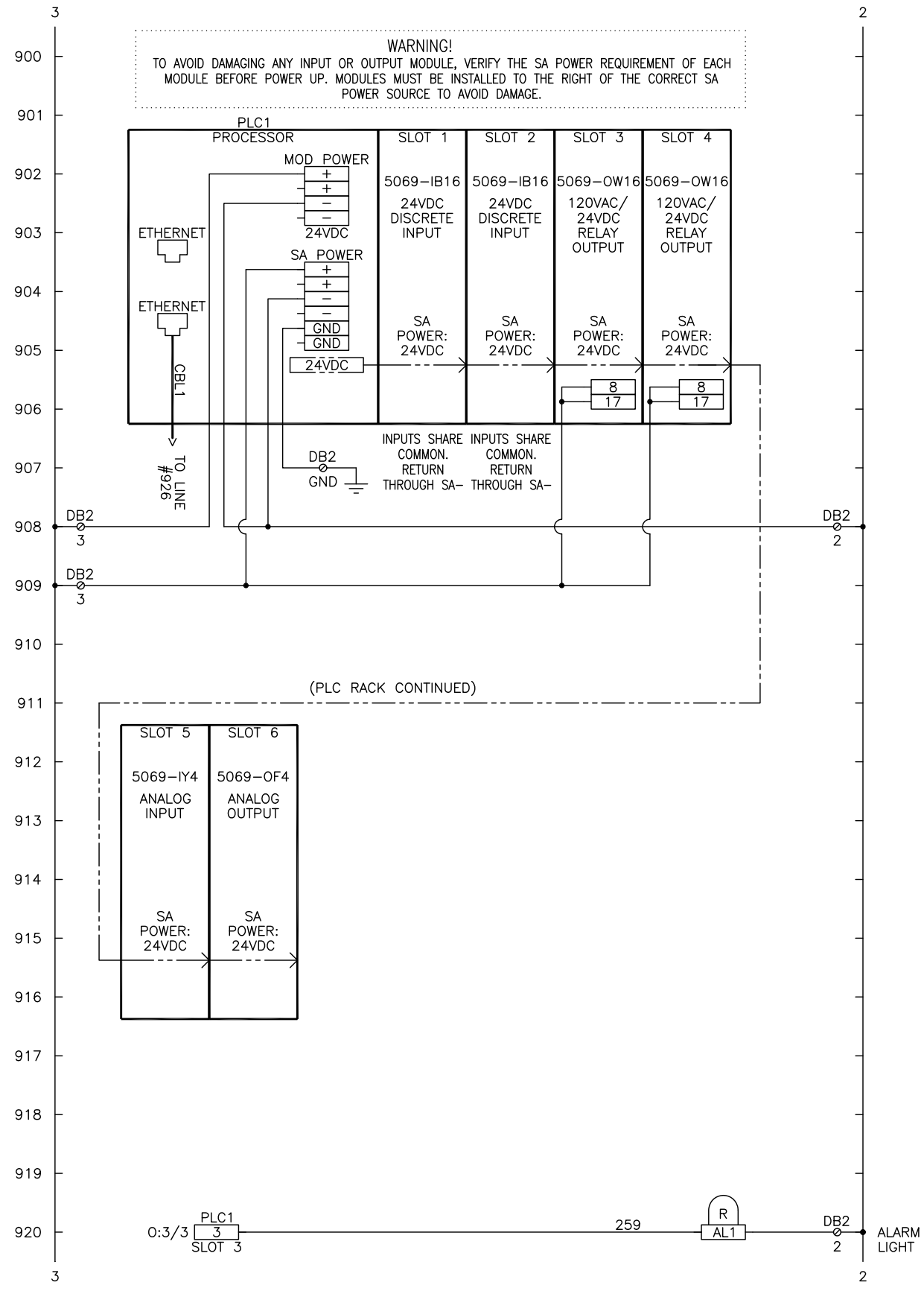
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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI SCALE: NONE

PROJECT NUMBER: 73010851 DRAWING NO: HBR9464A08

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Q-PRESS CONTROL PANEL

MT. CLEMENS, MI

PROJECT NUMBER: 73010851

DRAWING NO: HBR9464A09

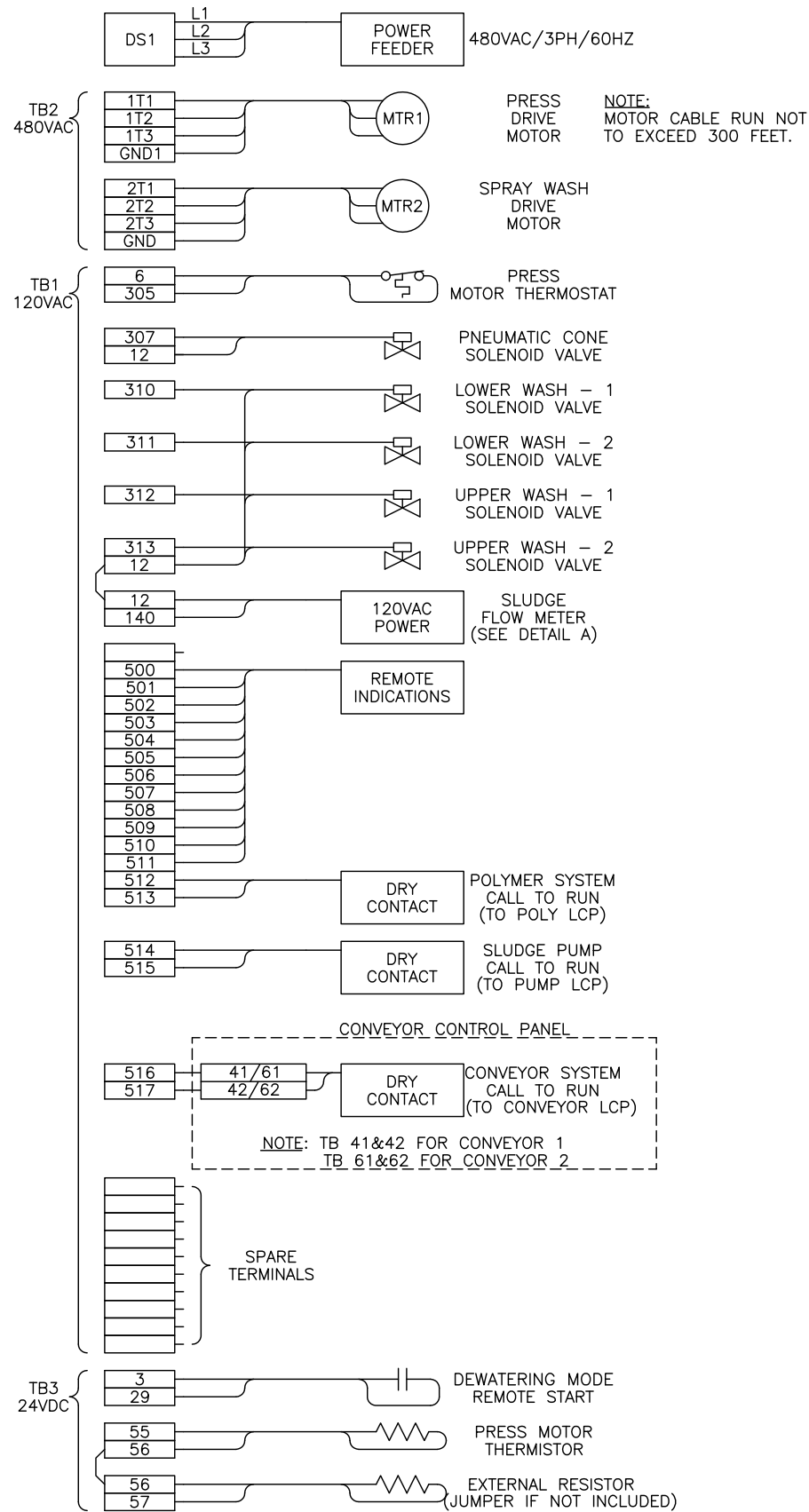
SCALE: NONE

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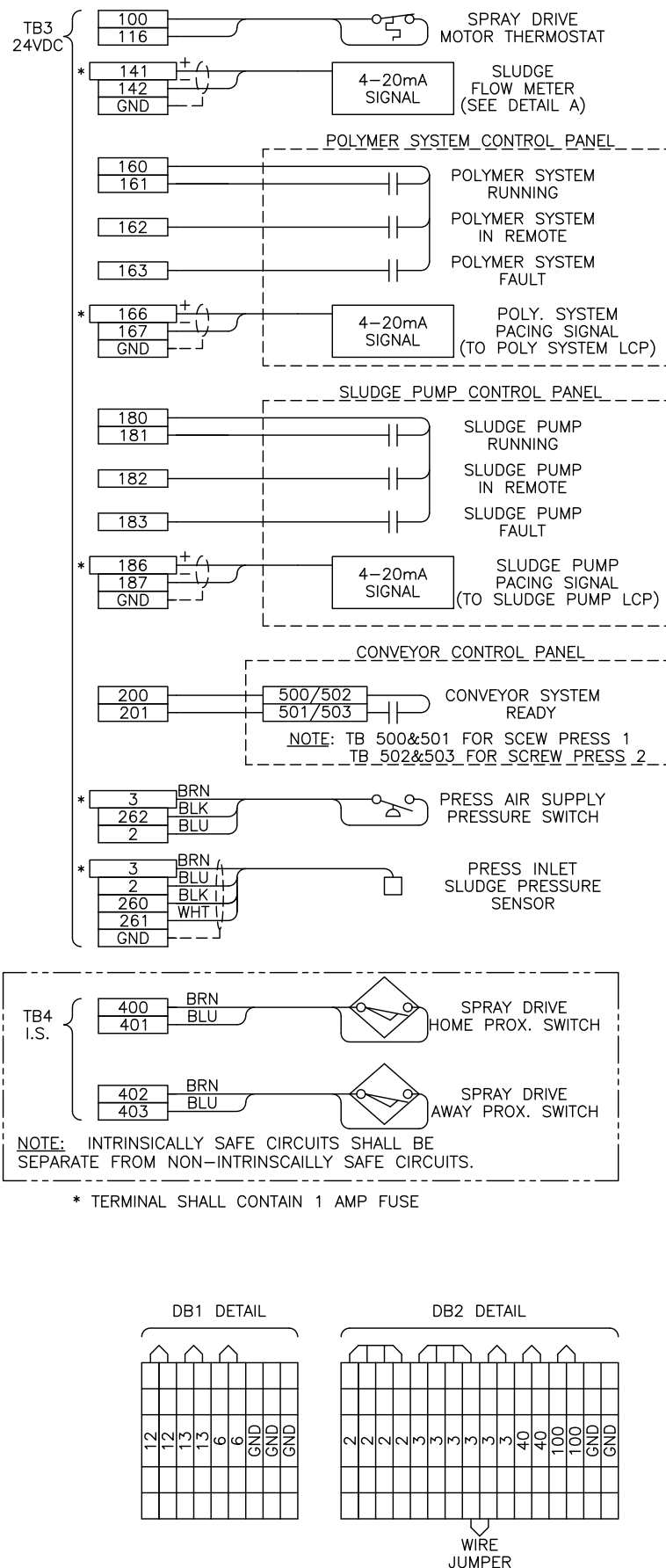
FIELD WIRING DIAGRAM

WARNING DAMAGE RESULTING FROM INSTALLATION OF TOP ENTRY CONDUIT WILL VOID WARRANTY.

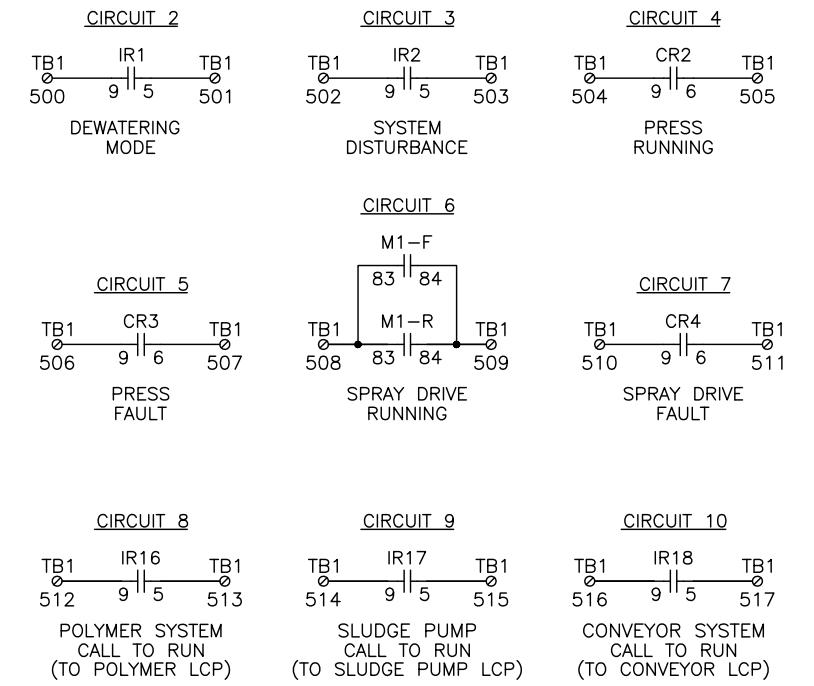
- AVOID CUTTING HOLES DIRECTLY ABOVE ANY ELECTRICAL COMPONENTS
- PROTECT INTERNAL COMPONENTS FROM METAL SHAVINGS, CUTTING OILS, DEBRIS, AND MOISTURE
- USE PROPER FITTINGS, MYERS TYPE 4 OR EQUAL
- CONDUITS AND FITTING MUST BE WATERTIGHT TO PREVENT WATER ENTRY
- ALL PENETRATIONS MUST BE SEALED OFF TO PREVENT INTRUSION OF MOISTURE, CORROSIVE GASES, AND VAPORS FROM ENTERING THE ENCLOSURE



FIELD WIRING DIAGRAM



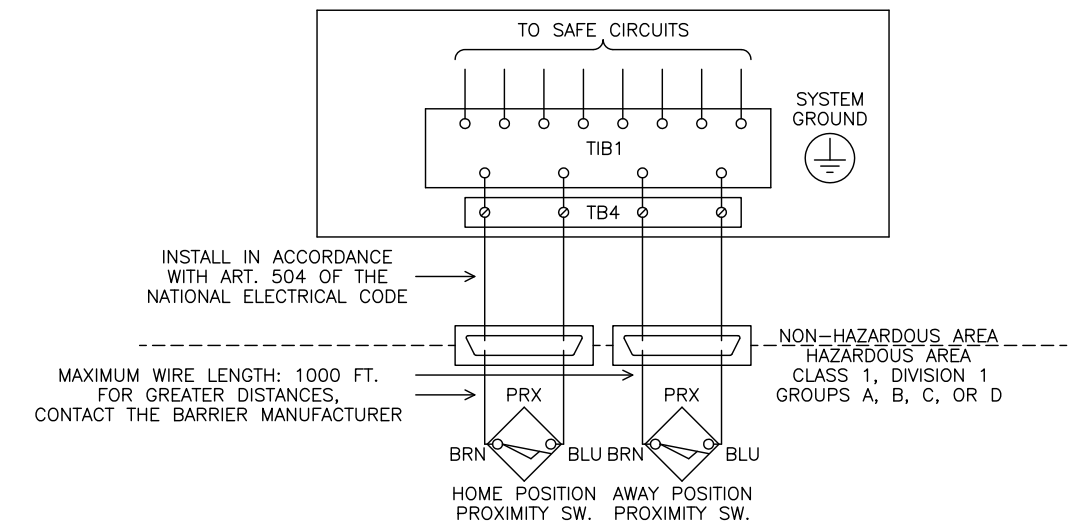
DRY CONTACTS FOR PLANT USE



MAX. CONTROLLED LOAD: 10A @ 120VAC

NOTE: BRANCH CIRCUIT PROTECTION PROVIDED BY OTHERS PER N.E.C.

TIB1 WIRING DETAIL



INSTALL IN ACCORDANCE WITH ART. 504 OF THE NATIONAL ELECTRICAL CODE

MAXIMUM WIRE LENGTH: 1000 FT. FOR GREATER DISTANCES, CONTACT THE BARRIER MANUFACTURER

NON-HAZARDOUS AREA
HAZARDOUS AREA
CLASS 1, DIVISION 1
GROUPS A, B, C, OR D

NOTES:

1. ENSURE CONTROL PANEL IS CONNECTED TO GROUND.
2. CAUTION: MAINTAIN SEPARATION BETWEEN INTRINSICALLY SAFE WIRING AND OTHER WIRING.

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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9464A10

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PLC/OIU SETTINGS

L306ER CPU	DISCRETE IN	DISCRETE OUT	ANALOG IN	ANALOG OUT
	QTY: 2 SLOT 1-2	QTY: 2 SLOT 3,4	QTY: 1 SLOT 5	QTY: 1 SLOT 6

PLC INPUTS - SLOT NO.1

I/0	E-STOP PRESSED
I/1	SYSTEM RESET
I/2	PRESS IN HAND/FORWARD
I/3	PRESS IN HAND/REVERSE
I/4	PRESS IN AUTO
I/5	PRESS OVERLOAD
I/6	PRESS RUNNING
I/7	PRESS MOTOR T-STAT
I/8	SPRAY WASH IN HAND
I/9	SPRAY WASH IN AUTO
I/10	SPRAY DRIVE HOME POSITION
I/11	SPRAY DRIVE AWAY POSITION
I/12	PRESS REMOTE START
I/13	SPARE
I/14	POWER FEED OK
I/15	AIR SUPPLY OK

PLC INPUTS - SLOT NO.2

I/0	POLYMER SYSTEM RUNNING
I/1	POLYMER SYSTEM IN REMOTE
I/2	POLYMER SYSTEM FAULT
I/3	SLUDGE PUMP RUNNING
I/4	SLUDGE PUMP IN REMOTE
I/5	SLUDGE PUMP FAULT
I/6	CONVEYOR SYSTEM READY
I/7	SPARE
I/8	SPARE
I/9	SPRAY DRIVE RUN REVERSE
I/10	SPRAY DRIVE RUN FORWARD
I/11	SPRAY DRIVE HIGH CURRENT
I/12	SPRAY DRIVE OVERLOAD
I/13	SPRAY DRIVE MOTOR T-STAT
I/14	SPRAY DRIVE IN HAND
I/15	SPRAY DRIVE IN AUTO

PLC OUTPUTS - SLOT NO.3

O/0	CONTROL POWER ENABLE
O/1	PRESS DEWATERING MODE
O/2	PRESS SYSTEM DISTURBANCE
O/3	COMMON ALARM
O/4	SPARE
O/5	SPARE
O/6	SPARE
O/7	SPARE
O/8	PRESS CALL TO RUN FORWARD
O/9	PRESS CALL TO RUN REVERSE
O/10	PRESS FAULT
O/11	PRESS PNEUMATIC CONE ENGAGE
O/12	SPARE
O/13	POLYMER SYSTEM CALL TO RUN
O/14	SPARE
O/15	SPARE

PLC OUTPUTS - SLOT NO.4

O/0	PRESS LOWER WASH 1 CALL
O/1	PRESS LOWER WASH 2 CALL
O/2	PRESS UPPER WASH 1 CALL
O/3	PRESS UPPER WASH 2 CALL
O/4	SPRAY DRIVE CALL REVERSE
O/5	SPRAY DRIVE CALL FORWARD
O/6	SPRAY DRIVE FAULT
O/7	SLUDGE PUMP CALL TO RUN
O/8	SPARE
O/9	CONVEYOR SYSTEM CALL TO RUN
O/10	SPARE
O/11	SPARE
O/12	SPARE
O/13	SPARE
O/14	SPARE
O/15	SPARE

PLC ANALOG INPUTS - SLOT NO.5

IN0	SLUDGE FEED FLOW RATE
IN1	SPARE
IN2	PRESS INLET PRESSURE
IN3	SPARE

PLC ANALOG OUTPUTS - SLOT NO.6

OUT0	POLYMER SPEED COMMAND
OUT1	SLUDGE PUMP SPEED COMMAND
OUT2	SPARE
OUT3	SPARE

PLC/OIU SETTINGS

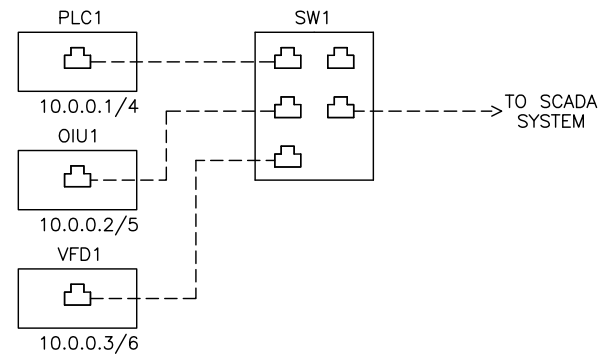
PLC1 - COMMUNICATIONS SETUP

ETHERNET PORT PARAMETERS	VALUE
IP ADDRESS PANEL 1	10.0.0.1
IP ADDRESS PANEL 2	10.0.0.4
SUBNET MASK	255.255.255.0
GATEWAY ADDRESS	0.0.0.0
BOOTP ENABLE	NO

OIU1 - COMMUNICATIONS SETUP

ETHERNET PORT PARAMETERS	VALUE
IP ADDRESS PANEL 1	10.0.0.2
IP ADDRESS PANEL 2	10.0.0.5
SUBNET MASK	255.255.255.0
GATEWAY ADDRESS	0.0.0.0
BOOTP ENABLE	NO

ETHERNET NETWORK MAP



NOTES:

1. --- CAT5 ETHERNET CABLE

SUBNET MASK: 255.255.255.0

PLC/OIU SETTINGS

Q-PRESS SYSTEM OIU MAINTENANCE REMINDERS

PART DESCRIPTION	OPERATING TIME (HOURS)
INSPECT WIPER	2000
INSPECT COMPLETE SPRAY CAROUSEL	2000
INSPECT LOWER SHAFT SEALS & BUSHING	2000
INSPECT UPPER AUGER SHAFT BEARING	2000
INSPECT SOLENOID VALVES	100
INSPECT WASH SYSTEM HOSES	2000
REPLACE GEARBOX OIL	10000

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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9464A11

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PLC/OIU SETTINGS

PLC1 - SETPOINTS

REGISTER	DESCRIPTION	UNITS	DEFAULT	MIN	MAX
SP1[0].INT	EQUIPMENT STARTUP DELAY	SEC.	3	0	10
SP1[1].INT	DURATION MODE RUN DURATION	MIN.	900	1	9999
SP1[2].INT	VOLUME MODE PROCESS VOLUME	GAL	100	1	99999
SP1[3].INT	DATALOGGER INTERVAL	SEC.	10	1	999
SP1[10].INT	PRESS SHUTDOWN DURATION	MIN.	10	0	120
SP1[11].INT	PRESS DIRECTION CHANGE DWELL	SEC.	3	1	60
SP1[12].REAL	PRESS HAND SPEED	%	50	1	100
SP1[13].REAL	PRESS SPEED MINIMUM: LOW PRESSURE	%	10	1	100
SP1[14].REAL	PRESS SPEED MINIMUM: HIGH PRESSURE	%	50	1	100
SP1[15].REAL	PRESS SHUTDOWN SPEED	%	100	1	100
SP1[16].REAL	PRESS MAX TORQUE SPEED SETPOINT	%	60	1	100
SP1[17].REAL	PRESS HIGH PRESSURE INTERRUPT SPEED	%	100	1	100
SP1[20].INT	PNEUMATIC CONE AIR FAILURE FAULT DELAY	SEC.	10	1	20
SP1[40].INT	SPRAY WASH CYCLE DELAY	MIN.	15	1	60
SP1[41].INT	SPRAY WASH SHORT CYCLE COUNTER	COUNTS	2	1	10
SP1[42].INT	MAXIMUM TIME BETWEEN PROX. FAULT DELAY	SEC.	1	1	999
SP1[43].REAL	SPRAY DRIVE DIRECTION CHANGE DWELL	SEC.	1	0.5	999
SP1[44].REAL	SPRAY DRIVE INITIAL MOVE PROX. DELAY	SEC.	1	0.1	999
SP1[45].INT	SPRAY DRIVE FINAL FORWARD MOVE TIME	SEC.	5	1	30
SP1[60].REAL	INLET PRESSURE AT MIN SPEED	PSI	3	0	30
SP1[61].REAL	INLET PRESSURE AT MAX SPEED	PSI	15	0	30
SP1[62].REAL	INLET PRESSURE AT 4MA	PSI	0	0	30
SP1[63].REAL	INLET PRESSURE AT 20MA	PSI	14.7	0	30
SP1[64].REAL	HIGH PRESSURE INTERRUPT PRESSURE	PSI	12	0	30
SP1[65].INT	HIGH PRESSURE INTERRUPT OFF DELAY	SEC.	10	1	60
SP1[66].INT	MAINTAINED HIGH PRESSURE SHUTDOWN DELAY	SEC.	10	1	60
SP1[67].INT	HIGH PRESSURE COUNTS BEFORE SHUTDOWN	COUNTS	5	1	10
SP1[68].INT	HIGH PRESSURE COUNT RESET TIME	MIN.	60	1	600
SP1[69].INT	INLET PRESSURE DAMPENING TIME	SEC.	3	0	999
SP1[70].REAL	SLUDGE CONCENTRATION	%	3	0	10
SP1[71].REAL	REQUIRED SLUDGE FLOW RATE	GPM	30	5	150
SP1[72].REAL	SLUDGE PUMP MINIMUM SPEED	%	20	0	100
SP1[73].REAL	SLUDGE PUMP PID INITIAL SPEED	%	20	0	100
SP1[74].INT	SLUDGE PUMP PID ON DELAY	SEC.	10	0	999
SP1[75].REAL	SLUDGE PUMP PID GAIN (P) X 100	N/A	50	1	1000
SP1[76].REAL	SLUDGE PUMP PID TIME (I) X 10	N/A	12	1	1000
SP1[77].INT	SLUDGE ZERO FLOW FAULT DELAY	SEC.	300	1	999
SP1[78].INT	SLUDGE PUMP FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1[79].REAL	SLUDGE FLOW AT 4MA	GPM	0	0	500
SP1[80].REAL	SLUDGE FLOW AT 20MA	GPM	100	0	500
SP1[85].INT	GENERAL FAULT DELAY	SEC.	1	0	999
SP1[90].REAL	POLYMER CONCENTRATION	%	100	0.05	100
SP1[91].REAL	LBS POLY PER TON OF SLUDGE	LB/TON	10	0.1	199.9
SP1[92].REAL	POLYMER PUMP MINIMUM CAPACITY	GPH	0	0	9.9
SP1[93].REAL	POLYMER PUMP MAXIMUM CAPACITY	GPH	3	0	999.9
SP1[94].INT	POLYMER PUMP FAIL TO RUN FAULT DELAY	SEC.	10	1	999
SP1[104].INT	GENERAL FAULT DELAY	SEC.	1	0	999
SP1[105].REAL	POLYMER SYSTEM INITIAL SPEED	%	20	0	100
SP1[106].INT	POLYMER SYSTEM DOSING CALC ON DELAY	SEC.	5	1	999
SP1[111].INT	CONVEYOR SYSTEM OFF DELAY	SEC.	30	0	999
SP1[180].REAL	TORQUE AT MIN SPEED	NM	4.5	0	99.9
SP1[181].REAL	TORQUE AT MAX SPEED	NM	17.9	0	99.9
SP1[182].INT	HIGH TORQUE INTERRUPT TORQUE	NM	19	0	99.9
SP1[183].INT	HIGH TORQUE INTERRUPT OFF DELAY	SEC.	10	1	60
SP1[184].REAL	MAINTAINED HIGH TORQUE SHUTDOWN DELAY	MIN.	15	1	99
SP1[185].INT	HIGH TORQUE COUNTS BEFORE SHUTDOWN	COUNTS	5	1	10
SP1[186].INT	HIGH TORQUE COUNT RESET TIME	MIN.	60	1	600
SP1[187].INT	HIGH TORQUE INTERRUPT SPEED INCREASE	%	1	0	10
SP1[188].INT	TORQUE INTERRUPT SPEED INCREASE INTERVAL	SEC.	3	0	20
SP1[189].REAL	HIGH TORQUE OVERLOAD VALUE	NM	20	0	99.9
SP1[190].INT	TORQUE DAMPENING TIME	SEC.	200	0	999
SP1[191].INT	MOTOR NAMEPLATE POLES	POLES	4	2	8
SP1[192].INT	MOTOR MAX FREQUENCY	HZ	60	50	100

PLC/OIU SETTINGS

PLC1 - SCADA COMMUNICATIONS

REGISTER NUMBER	DESCRIPTION	DATA TYPE	NORMAL STATE	ACTIVE STATE	SCADA FUNCTION
PLC IO STATUS					
S_INT[1]	PLC SLOT 1 DISCRETE INPUTS	(BIT)	0	1	READ
S_INT[2]	PLC SLOT 2 DISCRETE INPUTS	(BIT)	0	1	READ
S_INT[3]	PLC SLOT 3 DISCRETE OUTPUTS	(BIT)	0	1	READ
S_INT[4]	PLC SLOT 4 DISCRETE OUTPUTS	(BIT)	0	1	READ
SCREW PRESS					
S_INT[9].0	PRESS RUNNING FORWARD	(BIT)	0	1	READ
S_INT[9].1	PRESS RUNNING REVERSE	(BIT)	0	1	READ
S_INT[9].2	PRESS IN AUTO	(BIT)	0	1	READ
S_INT[9].3	PRESS FAULT	(BIT)	0	1	READ
S_INT[9].4	PRESS IN DEWATERING MODE	(BIT)	0	1	READ
S_INT[9].5	SPRAY WASH ON	(BIT)	0	1	READ
S_INT[9].6	SPRAY IN AUTO	(BIT)	0	1	READ
S_INT[9].7	SPRAY DRIVE RUNNING	(BIT)	0	1	READ
S_INT[9].8	SPRAY DRIVE IN AUTO	(BIT)	0	1	READ
S_INT[9].9	SPRAY DRIVE FAULT	(BIT)	0	1	READ
S_INT[9].10	SYSTEM DISTURBANCE	(BIT)	0	1	READ
S_REAL[0]	PRESS MOTOR CURRENT (AMPS)	(REAL)	-	-	READ
S_REAL[1]	PRESS INLET PRESSURE (PSI)	(REAL)	-	-	READ
S_REAL[2]	PRESS SPEED FEEDBACK (%)	(REAL)	-	-	READ
S_REAL[3]	PRESS TORQUE (Nm)	(REAL)	-	-	READ
S_INT[100].0	DEWATERING REMOTE START	(BIT)	0	1	WRITE
SLUDGE PUMP					
S_INT[11].0	SLUDGE PUMP RUNNING	(BIT)	0	1	READ
S_INT[11].1	SLUDGE PUMP IN AUTO	(BIT)	0	1	READ
S_INT[11].2	SLUDGE PUMP FAULT	(BIT)	0	1	READ
S_REAL[11]	SLUDGE FEED FLOW RATE (GPM)	(REAL)	-	-	READ
POLYMER SYSTEM					
S_INT[13].0	POLYMER SYSTEM RUNNING	(BIT)	0	1	READ
S_INT[13].1	POLYMER SYSTEM IN REMOTE	(BIT)	0	1	READ
S_INT[13].2	POLYMER SYSTEM FAULT	(BIT)	0	1	READ
CONVEYOR SYSTEM					
S_INT[14].0	CONVEYOR SYSTEM READY	(BIT)	0	1	READ
GENERAL					
S_INT[15].0	E-STOP PRESSED	(BIT)	0	1	READ
S_INT[15].1	POWER FEED OK	(BIT)	0	1	READ

DESIGNED	JN			
DETAILED				
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NO.	BY	CK	APP	DATE

HUBER
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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9464A12

DEVICE SETTINGS

CM1 - CURRENT MONITOR

DIP SETTINGS	
1	ON
2	OFF
3	ON
4	OFF
5	OFF
6	ON

DIAL SETTINGS	
HYSTERESIS	0%
LEVEL	FLA
DELAY	0.5s

WIRE PASSES	MAX AMPS	LEVEL RANGE (10-110%)
1	20	2-22A
2	10	1-11A
3	6.6	0.6-7.3A
4	5	0.5-5.5A

* ABOVE VALUES ASSUME 20A MAX DIP SETTINGS

NOTES:

- FIELD CONFIGURATION SHALL BE PERFORMED BY THE STARTUP TECHNICIAN PER THE APPROPRIATE TECHNICAL DOCUMENTS.
- MEASURING RANGE MAXIMUM AMPS SET BY DIP SETTINGS 1 AND 2
SW1 ON/SW2 OFF = 20A; SW1 ON/SW2 ON = 50A; SW1 OFF/SW2 ON = 100A

TS1 - SETTINGS

FAN OFF/ON	60 °F
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TIB1 - SETTINGS

JUMPER NUMBER	SET AT
CH1	JP11 1-2 (DIRECT)
	JP12 2-3 (OFF)
CH2	JP21 1-2 (DIRECT)
	JP22 2-3 (OFF)
	JP23 2-3 (IN. 2 ACTIVE)

AL1 - ALARM LIGHT

SWITCH	SINGLE FLASH SETTING
1 2	SWITCH 1 = ON
<input type="checkbox"/> <input type="checkbox"/>	SWITCH 2 = OFF
FLASH	

PFR1 - SETTINGS

DIAL	SETTING
VOLTAGE	480 ON DELAY
Tt	5s
>U	10%
<U	10%

DEVICE SETTINGS

VFD1 - POWERFLEX 525 SETTINGS

PARAMETER NUMBER	DESCRIPTION	DEFAULT	VFD1 SETTING
31	MOTOR VOLTAGE	460 VAC	460 VAC
32	MOTOR FREQUENCY	60 HZ	70 HZ
33	MOTOR OL CURRENT	*	7.1 AMPS
34	MOTOR NP FLA	*	7.1 AMPS
35	MOTOR NP POLES	*	4 POLES
36	MOTOR NP RPM	*	2100 RPM
37	MOTOR NP POWER (kW)	*	4 kW
39	TORQUE PERF MODE	1=SVC	4=PM MOTOR
41	ACCEL TIME 1	10 SEC.	5 SEC.
42	DECEL TIME 1	10 SEC.	5 SEC.
44	MAXIMUM FREQUENCY	60 HZ	70 HZ
45	STOP MODE	0=RAMP	5=COAST
46	START SOURCE	1=KEYPAD	2=DIGIN TRMBLK
47	SPEED REFERENCE 1	1=DRIVE POT	15=ETHERNET/IP

TERMINAL BLOCK GROUP

65	DIG IN TERM BLK 05	7=PRESET FREQ.	12=AUX FAULT
76	RELAY OUT 1	0=READY	7=ABOVE CURRENT
77	RELAY OUT 1 LEVEL	0%	55%*
81	RELAY OUT 2 SEL	0=READY/FIT	10=ABOVE ANLG V
82	RELAY OUT 2 LEVEL	0	*

COMMUNICATIONS GROUP

125	COMM LOSS ACTION	0=FAULT	1=COAST STOP
128	EN ADDR SEL	0=BOOTP	1=PARAMETERS
129	EN IP ADDR CFG 1	0	10
130	EN IP ADDR CFG 2	0	0
131	EN IP ADDR CFG 3	0	0
132	EN IP ADDR CFG 4	0	3/6
133	EN SUBNET CFG 1	0	255
134	EN SUBNET CFG 2	0	255
135	EN SUBNET CFG 3	0	255
136	EN SUBNET CFG 4	0	0
137	EN GATEWAY CFG 1	0	0
138	EN GATEWAY CFG 2	0	0
139	EN GATEWAY CFG 3	0	0
140	EN GATEWAY CFG 4	0	0
143	EN COMM FLT ACTN	0=FAULT	3=HOLD LAST
144	EN IDLE FLT ACTN	0=FAULT	3=HOLD LAST
157	EN DATA OUT 1	0	3=OUTPUT CURRENT
158	EN DATA OUT 1	0	44=MAX. OUTPUT FREQ.

ADVANCED PROGRAM GROUP

440	PWM FREQUENCY	4.0 KHZ	6.0 KHZ
501	PM IR VOLTAGE	11.50 V	(AUTOTUNE-NOTE 5)
502	PM IXd VOLTAGE	17.91 V	(AUTOTUNE-NOTE 5)
503	PM IXq VOLTAGE	53.21 V	(AUTOTUNE-NOTE 5)
504	PM BEMF VOLTAGE	1640.0 DRV	(AUTOTUNE-NOTE 5)

NOTES:

- THE ABOVE IS A PARTIAL LISTING OF SETPOINTS. ONLY THE SETPOINTS THAT ARE SHOWN ABOVE MARKED WITH A * SHALL BE ALTERED IN THE FIELD. REFER TO THE DRIVE MANUAL FOR A FULL LIST OF SETPOINTS AND ADDITIONAL DETAILS.
- PARAMETER 77 MUST BE SET TO THE MOTOR OVERLOAD TRIP POINT WHICH IS A PERCENT OF THE MAXIMUM DRIVE OUTPUT CURRENT.
(MAX DRIVE OUTPUT CURRENT VFD1 = 13A)
- VERIFY ALL MOTOR PARAMETERS TO THE ACTUAL MOTOR NAMEPLATE.
- VFD1 IS CONFIGURED FOR A PERMANENT MAGNET MOTOR WITH A WYE WIRING CONFIGURATION. ENSURE MOTOR JUMPERS ARE SET UP FOR A WYE CONFIGURATION.
- PRIOR TO MOTOR START UP, AN AUTOTUNE MUST BE PERFORMED. ONCE MOTOR NAMEPLATE PARAMETERS ARE CONFIRMED, NAVIGATE TO PARAMETER P040 AND CHANGE P040 TO A VALUE OF 1. PROVIDE THE VFD WITH A MAINTAINED MANUAL/HAND MODE CALL TO RUN. DURING THIS TIME, THE VFD WILL DISPLAY "RUN", BUT THE MOTOR WILL NOT OPERATE. ONCE THE AUTOTUNE IS FINISHED "RUN" WILL BE REMOVED FROM THE DISPLAY.

VFD1 - ETHERNET PORT

PARAMETERS	VALUE
IP ADDRESS PANEL 1	10.0.0.3
IP ADDRESS PANEL 2	10.0.0.6
SUBNET MASK	255.255.255.0
GATEWAY ADDRESS	0.0.0.0

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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI

SCALE:
NONE

PROJECT NUMBER:
73010851

DRAWING NO:
HBR9464A13
13 OF 17

SEQUENCE OF OPERATION

CONTROL POWER ON-DELAY:

EACH TIME THE CONTROL PANEL POWER SUPPLY IS CYCLED, THE PLC WILL ALLOW ALL SOLID STATE DEVICES TO FULLY ENERGIZE BEFORE ENABLING THE CONTROL POWER CIRCUIT.

PRESS MODES OF OPERATION:

HAND: WHEN THE PRESS SELECTOR IS IN THE HAND POSITION, THE PRESS WILL RUN IN THE DIRECTION SELECTED BY THE PRESS FOR-OFF-REV SELECTOR AT A CONSTANT SPEED ENTERED BY THE OPERATOR INTO THE OIU.

NOTE: IN HAND MODE, THE PRESS WILL RUN FORWARD ONCE THE PNEUMATIC CONE HAS BEEN ACTUATED.

AUTO: WHEN THE PRESS SELECTOR IS IN THE AUTO POSITION THE PRESS WILL BEGIN TO CYCLE IN THE FORWARD DIRECTION AS DESCRIBED IN THE SYSTEM START SEQUENCE. ONCE RUNNING, THE PRESS WILL OPERATE AT SPEED BASED ON THE MEASURED MOTOR TORQUE AND INLET PRESSURE, AS DESCRIBED BELOW. THE PRESS WILL CONTINUE TO CYCLE UNTIL THE SYSTEM ENTERS SHUTDOWN MODE.

PRESS INTERLOCKS:

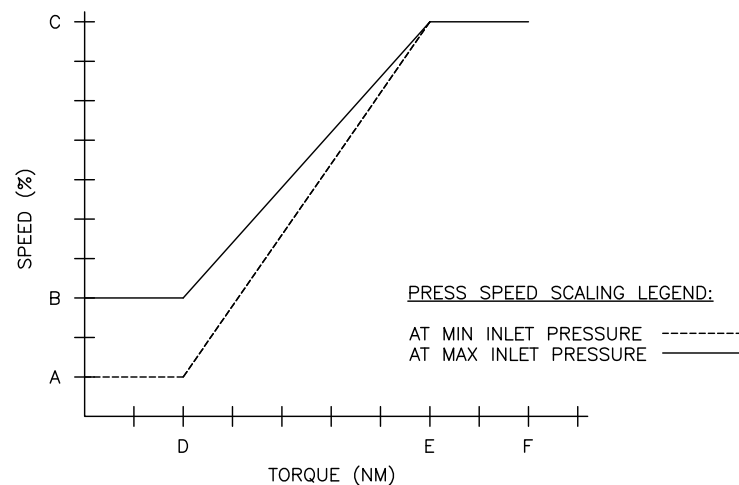
OPERATING THE PRESS, IN HAND OR AUTOMATIC, WILL REQUIRE THE FOLLOWING:

- PRESSURIZED AIR SUPPLY TO BE ABOVE THE REQUIRED PRESSURE AS MEASURED BY THE PRESSURE SWITCH IN THE AIR SUPPLY LINE.
- THE SOLENOID VALVE FOR THE PNEUMATIC ACTUATED CONE MUST ALSO BE ENERGIZED, UNLESS IN SLUDGE DEWATERING SYSTEM SHUTDOWN SEQUENCE.

PRESS SPEED CONTROL:

- THE PRESS MINIMUM SPEED SETTING WILL BE LINEARLY ADJUSTED BASED ON THE MEASURED PRESS INLET PRESSURE. WHEN THE PRESS INLET PRESSURE IS AT OR BELOW THE INLET PRESSURE AT MINIMUM SPEED SETPOINT, THE PRESS MINIMUM SPEED SETTING WILL BE SET TO THE PRESS SPEED MINIMUM: LOW PRESSURE SETPOINT. WHEN THE PRESS INLET PRESSURE IS AT OR ABOVE THE INLET PRESSURE AT MAXIMUM SPEED SETPOINT, THE PRESS MINIMUM SPEED SETTING WILL BE SET TO THE PRESS SPEED MINIMUM: HIGH PRESSURE SETPOINT.
- THE OVERALL PRESS SPEED WILL BE LINEARLY ADJUSTED BASED ON THE MEASURED PRESS TORQUE. WHEN THE PRESS TORQUE IS AT OR BELOW THE TORQUE AT MINIMUM SPEED SETPOINT, THE PRESS WILL OPERATE AT THE PRESS MINIMUM SPEED SETTING BASED ON PRESSURE, AS DESCRIBED ABOVE. WHEN THE PRESS TORQUE IS AT OR ABOVE THE TORQUE AT MAXIMUM SPEED SETPOINT, THE PRESS WILL OPERATE AT THE PRESS DEWATERING MODE MAXIMUM SPEED SETPOINT.
- THE SPEED RATE OF CHANGED BASED ON THE MEASURED INLET PRESSURE AND TORQUE CAN BE AVERAGED OVER A SET TIME BY THE INLET PRESSURE AND TORQUE DAMPENING SETPOINTS.

SPEED VS. MOTOR TORQUE



PRESS SPEED SCALING LEGEND:

AT MIN INLET PRESSURE -----
 AT MAX INLET PRESSURE _____

SPEED / MOTOR TORQUE SCALING SETPOINTS:

- A. PRESS SPEED MINIMUM: LOW PRESSURE SETPOINT
- B. PRESS SPEED MINIMUM: HIGH PRESSURE SETPOINT
- C. PRESS MAXIMUM TORQUE SPEED SETPOINT
- D. TORQUE AT MINIMUM SPEED SETPOINT
- E. TORQUE AT MAXIMUM SPEED SETPOINT
- F. HIGH TORQUE INTERRUPT SETPOINT

NOTES: THE MOTOR TORQUE WILL BE CALCULATED BY THE PLC USING THE FOLLOWING CALCULATION:

$$\text{MOTOR TORQUE (NM)} = \text{MOTOR POWER (W)} * 9.5488 / \text{MOTOR SPEED (RPM)}$$

THE MOTOR SPEED (RPM) WILL BE CALCULATED BY THE PLC USING THE FOLLOWING CALCULATION:

$$\text{MOTOR SPEED (RPM)} = \text{COMMANDED SPEED (HZ)} * (2 / \text{MOTOR POLES}) * 60$$

THE OPERATOR WILL NEED TO ENTER THE MOTOR NAMEPLATE POLES, POWER, AND MAX FREQUENCY THROUGH THE OIU.

SEQUENCE OF OPERATION

SPRAY DRIVE MODES OF OPERATION:

HAND: WHEN THE SPRAY DRIVE SELECTOR IS IN THE HAND POSITION, THE SPRAY DRIVE WILL DWELL, THEN MOVE IN THE OPPOSITE DIRECTION OF ITS LAST MOVEMENT. IT WILL CONTINUE IN THIS DIRECTION UNTIL THE SPRAY DRIVE PROXIMITY SWITCH IS ACTIVATED. ONCE THE PROXIMITY SWITCH IS ACTIVATED, THE SPRAY DRIVE WILL STOP, DWELL, AND START TO RUN IN THE OPPOSITE DIRECTION. THE DWELL-FORWARD-DWELL-REVERSE CYCLES WILL CONTINUE UNTIL THE SPRAY DRIVE SELECTOR IS PLACED IN THE OFF POSITION.

AUTO: WHEN THE SPRAY DRIVE SELECTOR IS IN THE AUTO POSITION, THE SPRAY DRIVE WILL OPERATE AS DESCRIBED IN THE SPRAY WASH SYSTEM SEQUENCE.

SPRAY WASH MODES OF OPERATION:

HAND: WHEN THE SPRAY WASH SELECTOR IS IN THE HAND POSITION, ALL SPRAY WASH SOLENOID VALVES WILL ENERGIZE AND REMAIN ENERGIZED UNTIL THE SELECTOR IS PLACED IN THE OFF POSITION.

AUTO: WHEN THE SPRAY WASH SELECTOR IS IN THE AUTO POSITION, THE SPRAY WASH SOLENOID VALVES WILL OPERATE AS DESCRIBED IN THE SPRAY WASH SYSTEM SEQUENCE.

POLYMER SYSTEM MODES OF OPERATION:

WHEN THE POLYMER SYSTEM IS IN REMOTE, THE DEWATERING CONTROL PANEL WILL PROVIDE A CALL TO RUN SIGNAL AS WELL AS A CALCULATED PACING SIGNAL. THE CALL TO RUN AND PACING SIGNALS WILL BE ACTIVE WHILE THE SYSTEM IS IN DEWATERING MODE. THE POLYMER SYSTEM WILL START TO OPERATE AT THE INITIAL SPEED SETPOINT FOR THE TIME SET IN THE DOSING CALCULATION ON DELAY TIMER. THE POLYMER SYSTEM SPEED WILL THEN VARY BASED ON THE SLUDGE CALCULATIONS VARIABLES EXPLAINED BELOW. THESE SIGNALS WILL BE DE-ACTIVATED WHEN THE SYSTEM ENTERS SHUTDOWN MODE.

SLUDGE PUMP MODES OF OPERATION:

WHEN THE SLUDGE FEED PUMP IS IN REMOTE, THE DEWATERING CONTROL PANEL WILL PROVIDE A CALL TO RUN SIGNAL AS WELL AS A USER SET PACING SIGNAL. THE CALL TO RUN AND PACING SIGNALS WILL BE ACTIVE WHILE THE SYSTEM IS IN DEWATERING MODE. THE SLUDGE PUMP WILL START TO OPERATE AT THE PID MINIMUM SPEED SETPOINT FOR THE TIME SET IN THE PID ON DELAY TIMER. THE SLUDGE PUMP SPEED WILL THEN VARY BASED ON THE SLUDGE FLOW FEEDBACK RECEIVED FROM THE FLOW METER. THESE SIGNALS WILL BE DE-ACTIVATED WHEN THE SYSTEM ENTERS SHUTDOWN MODE.

SLUDGE CALCULATIONS:

THE USER WILL BE RESPONSIBLE FOR ENTERING THE FOLLOWING PARAMETERS TO ENSURE THE CORRECT AMOUNT OF POLYMER IS DOSED WITH THE SLUDGE:

- SLUDGE FEED FLOW RATE (GPM)
- SLUDGE CONCENTRATION (% SOLIDS CONCENTRATION)
- POLYMER DOSING RATE (LBS. NEAT POLYMER / TON DRY SOLIDS)
- POLYMER CONCENTRATION (%)

CONVEYOR SYSTEM OPERATION:

THE CONVEYOR SYSTEM WILL BE CALLED TO RUN WHENEVER THE PRESS IS RUNNING. THE CONVEYOR SYSTEM WILL CONTINUE TO RUN AFTER THE PRESS HAS STOPPED FOR THE TIME SET IN THE CONVEYOR SYSTEM OFF DELAY TIMER SET THROUGH THE OIU.

PNEUMATIC PRESSURE CONE:

THE PNEUMATIC PRESSURE CONE IS OPERATED BY A SOLENOID VALVE. PRIOR TO EACH OPERATION OF THE PRESS, THE SOLENOID VALVE WILL BE ENERGIZED. THE ACTIVATION OF THE PNEUMATIC PRESSURE CONE IS REQUIRED PRIOR TO ANY OPERATION OF THE PRESS.

SEQUENCE OF OPERATION

DEWATERING MODE START SEQUENCE:

A DEWATERING MODE WILL BEGIN WHEN THE USER PRESSES THE START PUSHBUTTON ON THE OIU, AND THE EQUIPMENT WILL START UP IN THE FOLLOWING ORDER:

- LONG WASH CYCLE WILL INITIATE
- THE CONVEYOR SYSTEM WILL BE CALLED TO RUN
- THE PNEUMATIC ACTUATED CONE IS ACTIVATED
- PRESS WILL START TO RUN
- POLYMER SYSTEM WILL BE CALLED TO RUN
- SLUDGE PUMP WILL BE CALLED TO RUN

NOTE:

- THERE WILL BE A DELAY BETWEEN THE START-UP OF EACH STEP.
- A DEWATERING SYSTEM MAY ALSO BE STARTED BY RECEIVING A REMOTE START SIGNAL.
- IF THE SYSTEM HAS STARTED DUE TO A REMOTE START SIGNAL, THE START PUSHBUTTON ON THE OIU WILL BE REPLACED WITH INDICATION THAT THE SYSTEM IS "IN REMOTE".
- IF POWER IS LOST AND RESTORED TO THE SYSTEM AFTER A DEWATERING MODE HAS STARTED VIA THE START PUSHBUTTON ON THE OIU, THE OPERATOR WILL NEED TO RESTART THE SYSTEM FROM THE OIU ONCE AGAIN.
- IF POWER IS LOST AND RESTORED TO THE SYSTEM AFTER A DEWATERING MODE HAS STARTED VIA THE REMOTE START SIGNAL AND THE SIGNAL IS STILL PRESENT, THE SYSTEM WILL AUTOMATICALLY START BACK UP.
- IN THE PRESS SETTING MENU ON THE OIU, THE OPERATOR WILL FIND MULTIPLE MODES OF OPERATION FOR THE DEWATERING MODE WHICH CAN BE ENABLED OR DISABLED:
 - START-STOP OPERATION. STARTING AND STOPPING THE SYSTEM BASED OFF PRESSING THE START AND STOP SOFT PUSHBUTTONS.
 - TIME ON AND TIME OFF OPERATION. STARTING AND STOPPING THE SYSTEM AT USER SET TIMES OF THE DAY.
 - RUN TIME OPERATION. STOPPING THE SYSTEM AFTER A USER SET TIME HAS ELAPSED.
 - PROCESSED VOLUME OPERATION. STOPPING THE SYSTEM AFTER A USER SET AMOUNT OF VOLUME HAS BEEN PROCESSED.
- WHEN THE DEWATERING SYSTEM IS AUTO-READY, THE PRESS CAN BE STARTED BY HOLDING THE RESET PUSHBUTTON FOR 5 SECONDS. ONCE THE DEWATERING MODE HAS STARTED, THE PRESS CAN BE PLACED INTO SHUTDOWN MODE BY HOLDING THE RESET PUSHBUTTON FOR 5 SECONDS.

SPRAY WASH SYSTEM SEQUENCE:

ONCE A SPRAY WASH CYCLE IS INITIATED, LOWER WASH 1 WILL OPEN AND THE SPRAY DRIVE WILL RETURN TO THE HOME POSITION. ONCE AT HOME, A SHORT SPRAY WASH CYCLE WILL BEGIN. AFTER COMPLETING THE SHORT SPRAY WASH CYCLE, A USER ENTERED TIME BETWEEN WASH CYCLES WILL BEGIN TIMING. AFTER THIS TIME HAS EXPIRED, THE SYSTEM WILL INITIATE ANOTHER SHORT SPRAY WASH CYCLE. THESE CYCLES WILL CONTINUE UNTIL THE SYSTEM HAS COMPLETED THE USER ENTERED NUMBER OF SHORT SPRAY WASH CYCLES. ONCE THE NUMBER OF SHORT SPRAY WASH CYCLES HAS REACHED THE USER ENTERED SETTING, AND THE SPRAY WASH DWELL TIMER HAS EXPIRED, THE SYSTEM WILL INITIATE A LONG SPRAY WASH CYCLE. ONCE THE LONG SPRAY WASH CYCLE IS COMPLETE, THE SEQUENCE WILL REPEAT ITSELF.

SHORT SPRAY WASH CYCLE:

THE FIRST LOWER WASH WILL REMAIN OPEN AND THE SPRAY DRIVE WILL DWELL. AFTER DWELLING, THE SPRAY DRIVE WILL ROTATE IN THE FORWARD DIRECTION UNTIL THE AWAY PROXIMITY SWITCH IS ACTIVATED. AFTER ACTIVATING THE AWAY PROXIMITY SWITCH, THE SPRAY DRIVE WILL STOP, LOWER WASH 1 WILL CLOSE, AND THE SECOND LOWER WASH WILL OPEN. THE SPRAY DRIVE WILL AGAIN DWELL. AFTER DWELLING, THE SPRAY DRIVE WILL ROTATE IN THE REVERSE DIRECTION UNTIL THE HOME PROXIMITY SWITCH IS ACTIVATED. AFTER ACTIVATING THE HOME PROXIMITY SWITCH THE SPRAY DRIVE WILL STOP AND LOWER WASH 2 WILL CLOSE. AFTER DWELLING, THE SPRAY DRIVE WILL OPERATE IN THE FORWARD DIRECTION FOR THE TIME SET IN THE FINAL FORWARD MOVEMENT TIMER.

LONG SPRAY WASH CYCLE:

A LONG SPRAY WASH CYCLE CONSISTS OF A SHORT SPRAY WASH CYCLE IN ADDITION TO THE FOLLOWING SEQUENCE. ONCE THE SHORT SPRAY WASH CYCLE IS COMPLETE, THE FIRST UPPER WASH WILL OPEN, AND THE SPRAY DRIVE MOTOR WILL DWELL. AFTER DWELLING, THE SPRAY DRIVE WILL ROTATE IN THE FORWARD DIRECTION UNTIL THE AWAY PROXIMITY SWITCH IS ACTIVATED. AFTER ACTIVATING THE AWAY PROXIMITY SWITCH, THE SPRAY DRIVE WILL STOP, UPPER WASH 1 WILL CLOSE, AND THE SECOND UPPER WASH WILL OPEN. THE SPRAY DRIVE WILL AGAIN DWELL. AFTER DWELLING THE SPRAY DRIVE WILL ROTATE IN THE REVERSE DIRECTION UNTIL THE HOME PROXIMITY SWITCH IS ACTIVATED. AFTER ACTIVATING THE HOME PROXIMITY SWITCH THE SPRAY DRIVE WILL STOP AND UPPER WASH 2 WILL CLOSE. AFTER DWELLING, THE SPRAY DRIVE WILL OPERATE IN THE FORWARD DIRECTION FOR THE TIME SET IN THE FINAL FORWARD MOVEMENT TIMER.

NOTES:

- IF THE SYSTEM IS NOT IN DEWATERING MODE AND THE SPRAY DRIVE AND SPRAY WASH SELECTORS ARE IN THE AUTO POSITION, A SPRAY WASH CYCLE WILL BE INITIATED WHEN THE PRESS IS RUNNING. DURING THIS CYCLE, THE SPRAY DRIVE AND SPRAY WASH WILL BOTH CYCLE THROUGH SHORT AND LONG SPRAY WASH CYCLES AS DESCRIBED IN THE SPRAY WASH SYSTEM SEQUENCE.
- THE DEWATERING SYSTEM WILL CONTINUE TO INITIATE SPRAY WASH CYCLES WHILE THE SYSTEM IS IN SHUTDOWN MODE.
- THE HOME POSITION WILL BE DEFINED AS THE FULLY REVERSED PROXIMITY POSITION.
- THE AWAY POSITION WILL BE DEFINED AS THE FULLY FORWARD PROXIMITY POSITION.
- THE SPRAY DRIVE OVER TRAVEL FAULT OCCURS WHEN THE HOME PROXIMITY SWITCH IS ACTIVATED WHEN OPERATING IN THE FORWARD DIRECTION, OR THE AWAY PROXIMITY SWITCH IS ACTIVATED WHEN OPERATING IN THE REVERSE DIRECTION.

DESIGNED	JN
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Q-PRESS
 CONTROL PANEL

MT. CLEMENS, MI

SCALE:
 NONE

PROJECT NUMBER:
 73010851

DRAWING NO:
 HBR9464A14

SEQUENCE OF OPERATION

PRESS HIGH PRESSURE FEED INTERRUPT:

WHEN THE PRESS INLET PRESSURE MEASURED EXCEEDS THE HIGH PRESSURE INTERRUPT SETPOINT, THE SLUDGE PUMP AND POLYMER FEED SIGNAL WILL SHUT DOWN IMMEDIATELY AND THE PRESS WILL RUN AT THE PRESS INTERRUPT SPEED SEPOINT. ONCE THE PRESSURE HAS DROPPED PAST THE HIGH PRESSURE INTERRUPT SETPOINT AND HOLDS FOR THE TIME SET IN THE HIGH PRESSURE INTERRUPT OFF DELAY, THE PUMPS WILL AUTOMATICALLY RESTART AND THE PRESS WILL RETURN TO ITS REGULAR SPEED.

PRESS HIGH PRESSURE SHUTDOWN:

HIGH PRESSURE SHUTDOWN WILL OCCUR IF THE NUMBER OF COUNTS OF HIGH PRESSURE INTERRUPTS, SET IN THE HIGH INLET PRESSURE FAULT COUNTER, OCCUR WITHIN A SET AMOUNT OF TIME. A HIGH PRESSURE SHUTDOWN WILL ALSO OCCUR ONCE THE HIGH PRESSURE SIGNAL IS REACHED AND MAINTAINED FOR A TIME SET IN THE MAINTAINED HIGH INLET PRESSURE SHUTDOWN DELAY TIMER. THE SYSTEM WILL ENTER SHUTDOWN MODE IMMEDIATELY WHEN A HIGH PRESSURE SHUTDOWN OCCURS.

NOTE: TO RESET A HIGH PRESSURE SHUTDOWN, PRESS THE RESET PUSHBUTTON.

PRESS HIGH TORQUE INTERRUPT:

WHEN THE PRESS MOTOR TORQUE MEASURED EXCEEDS THE HIGH TORQUE INTERRUPT SETPOINT, THE SLUDGE PUMP AND POLYMER FEED SIGNAL WILL SHUT DOWN IMMEDIATELY AND THE PRESSURE CONE WILL DE-ENERGIZE. THE PRESS WILL CONTINUE TO RUN AND GRADUALLY INCREASE SPEED BY THE % AMOUNT SET IN THE TORQUE INTERRUPT SPEED INCREASE SETPOINT EACH TIME THE TORQUE INTERRUPT SPEED INCREASE INTERVAL TIME SETPOINT HAS ELAPSED UNTIL THE PRESS IS OPERATING AT THE SPEED SET IN THE PRESS INTERRUPT SPEED SETPOINT. ONCE THE MOTOR TORQUE HAS DROPPED PAST THE HIGH TORQUE INTERRUPT SETPOINT AND HOLDS FOR THE TIME SET IN THE HIGH TORQUE INTERRUPT OFF DELAY, THE PUMPS WILL AUTOMATICALLY RESTART, THE PRESSURE CONE WILL BE ENERGIZED, AND THE PRESS WILL RETURN TO ITS REGULAR SPEED.

NOTE: IF THE SPRAY WASH CYCLE DELAY TIMER EXPIRES DURING A PRESS HIGH TORQUE INTERRUPT CONDITION, THE SPRAY WASH CYCLE WILL BE PAUSED UNTIL THE PRESS HIGH TORQUE INTERRUPT CONDITION IS REMOVED AND THE PRESSURE CONE HAS BEEN RE-ENERGIZED.

PRESS HIGH TORQUE INTERRUPT SHUTDOWN:

HIGH TORQUE SHUTDOWN WILL OCCUR IF THE NUMBER OF COUNTS OF HIGH TORQUE INTERRUPTS, SET IN THE HIGH TORQUE INTERRUPT FAULT COUNTER, OCCUR WITHIN A SET AMOUNT OF TIME. A HIGH TORQUE SHUTDOWN WILL ALSO OCCUR ONCE THE HIGH TORQUE SIGNAL IS REACHED AND MAINTAINED FOR A TIME SET IN THE MAINTAINED HIGH TORQUE SHUTDOWN DELAY TIMER. THE SYSTEM WILL ENTER SHUTDOWN MODE IMMEDIATELY WHEN A HIGH TORQUE SHUTDOWN OCCURS.

NOTE: TO RESET A HIGH TORQUE SHUTDOWN, PRESS THE RESET PUSHBUTTON.

SEQUENCE OF OPERATION

DEWATERING SYSTEM SHUTDOWN MODE CONDITIONS:

1. REMOTE CALL TO RUN SIGNAL REMOVED
 2. STOP PUSHBUTTON PRESSED ON THE OIU
 3. THE SPRAY WASH SELECTOR IS SWITCHED TO THE HAND OR OFF POSITION.
 4. THE SLUDGE PUMP IN REMOTE SIGNAL IS LOST.
 5. THE POLYMER SYSTEM IN REMOTE SIGNAL IS LOST.
- WHEN SHUTDOWN MODE CONDITIONS 1–5 OCCUR, THE SYSTEM WILL ENTER SHUTDOWN MODE.
6. SLUDGE PUMP FAULT INDICATION RECEIVED
 7. SLUDGE PUMP RUNNING INDICATION NOT RECEIVED WHILE CALLED TO RUN FOR THE TIME SET IN THE SLUDGE PUMP FAIL TO RUN FAULT DELAY TIMER
 8. POLYMER SYSTEM FAULT INDICATION RECEIVED FOR THE TIME SET IN THE GENERAL FAULT DELAY TIMER
 9. POLYMER SYSTEM RUNNING INDICATION NOT RECEIVED WHILE CALLED TO RUN FOR THE TIME SET IN THE POLYMER SYSTEM FAIL TO RUN FAULT DELAY TIMER
 10. ZERO SLUDGE FLOW INDICATION RECEIVED WHILE THE SYSTEM IS IN DEWATERING MODE FOR THE TIME SET IN THE SLUDGE ZERO FLOW FAULT DELAY TIMER
 11. AIR SUPPLY LOW PRESSURE INDICATION RECEIVED
 12. PRESS HIGH PRESSURE SIGNAL MAINTAINED FOR THE TIME SET IN THE HIGH PRESSURE SHUTDOWN DELAY TIMER
 13. PRESS HIGH PRESSURE SIGNAL RECEIVED FOR THE AMOUNT OF TIMES SET IN THE HIGH PRESSURE COUNTS BEFORE SHUTDOWN COUNTER
 14. PRESS HIGH TORQUE MAINTAINED FOR THE TIME SET IN THE HIGH TORQUE SHUTDOWN DELAY TIMER
 15. PRESS HIGH TORQUE RECEIVED FOR THE AMOUNT OF TIMES SET IN THE HIGH TORQUE COUNTS BEFORE SHUTDOWN COUNTER
- WHEN ANY OF SHUTDOWN MODE CONDITIONS 6 – 15 OCCUR, THE SYSTEM DISTURBANCE PILOT LIGHT WILL ENERGIZE AND THE SYSTEM WILL ENTER SHUTDOWN MODE. THE SYSTEM DISTURBANCE PILOT LIGHT WILL REMAIN ENERGIZED UNTIL THE CONDITION IS CORRECTED.

ONCE THE SYSTEM IS IN SHUTDOWN MODE, THE EQUIPMENT WILL POWER DOWN IN THE FOLLOWING ORDER:

1. SLUDGE PUMP AND POLYMER SYSTEM CALL TO RUN SIGNALS WILL BE REMOVED AND THE PNEUMATIC CONE WILL DISENGAGE.
2. THE PRESS AND SPRAY WASH WILL CONTINUE UNTIL THE SHUTDOWN TIMER HAS COMPLETED.
3. ONCE THE SHUTDOWN TIMER HAS EXPIRED THE SPRAY WASH WILL COMPLETE ONE LAST LONG SPRAY WASH CYCLE. DURING THE FINAL SPRAY WASH CYCLE THE PNEUMATIC CONE WILL BE RE-ENGAGED.
4. THE SYSTEM WILL REMAIN OFF UNTIL THE NEXT DEWATERING MODE IS ACTIVATED

SEQUENCE OF OPERATION

SYSTEM FAULTS:

1. PRESS VFD DETECTS OVERLOAD
 2. PRESS TORQUE OVERLOAD SETPOINT HAS BEEN REACHED
 3. PRESS MOTOR THERMOSTAT IS TRIPPED
 4. PRESS RUNNING INDICATION NOT RECEIVED WHILE CALLED TO RUN
 5. SPRAY DRIVE HIGH CURRENT DETECTED
 6. SPRAY DRIVE MOTOR OVERLOAD DETECTED
 7. SPRAY DRIVE MOTOR THERMOSTAT IS TRIPPED
 8. SPRAY DRIVE IS RUNNING REVERSE AND TRIGGERS THE AWAY PROXIMITY SWITCH.
 9. SPRAY DRIVE IS RUNNING FORWARD AND TRIGGERS THE HOME PROXIMITY SWITCH.
 10. SPRAY DRIVE IS RUNNING AND NEITHER PROXIMITY SWITCH IS TRIGGERED IN THE TIME SET IN THE OIU.
- WHEN ANY OF FAULTS 1 THROUGH 7 OCCUR, THE ALARM HORN, BEACON, AND SYSTEM DISTURBANCE PILOT LIGHT WILL ENERGIZE AND THE ENTIRE SYSTEM WILL SHUT DOWN IMMEDIATELY. THE ALARM BEACON AND SYSTEM DISTURBANCE PILOT LIGHT WILL REMAIN ENERGIZED UNTIL THE CONDITION IS CORRECTED.
- WHEN ANY OF FAULTS 8 THROUGH 10 OCCUR, THE ALARM HORN, BEACON, AND SYSTEM DISTURBANCE PILOT LIGHT WILL ENERGIZE AND THE ENTIRE SYSTEM WILL SHUT DOWN IMMEDIATELY. THE ALARM BEACON AND SYSTEM DISTURBANCE PILOT LIGHT WILL REMAIN ENERGIZED UNTIL THE OPERATOR ACKNOWLEDGES THE FOLLOWING PROMPTS:
- ALARM ANNUNCIATION MESSAGE
 - SPRAY DRIVE HAS MANUALLY BEEN ADJUSTED FROM THE OIU TO A SAFE POSITION
 - HOME AND AWAY PROXIMITY SWITCHES ARE WORKING PROPERLY

NOTES:

1. FOR SYSTEM FAULTS 10–12, THE SYSTEM RESET PUSHBUTTON WILL NOT BE ACTIVE UNTIL THE ABOVE THREE PROMPTS HAVE BEEN ACKNOWLEDGED BY THE OPERATOR.
2. IF THE PRESS OR SPRAY DRIVE SELECTORS ARE SWITCHED TO THE HAND OF OFF POSITION OR THE CONVEYOR SYSTEM READY SIGNAL IS LOST WHEN THE SYSTEM IS IN THE DEWATERING MODE, THE SYSTEM WILL SHUTDOWN IMMEDIATELY AND A MESSAGE WILL BE DISPLAYED ON THE OIU.

ALARM BEACON:

THE ALARM BEACON WILL ENERGIZE IF ANY OF THE SYSTEM FAULTS OCCUR. THE ALARM BEACON WILL REMAIN ENERGIZED UNTIL THE FAULT IS CLEARED AND THE SYSTEM RESET PUSHBUTTON IS PRESSED.


EMERGENCY STOP:

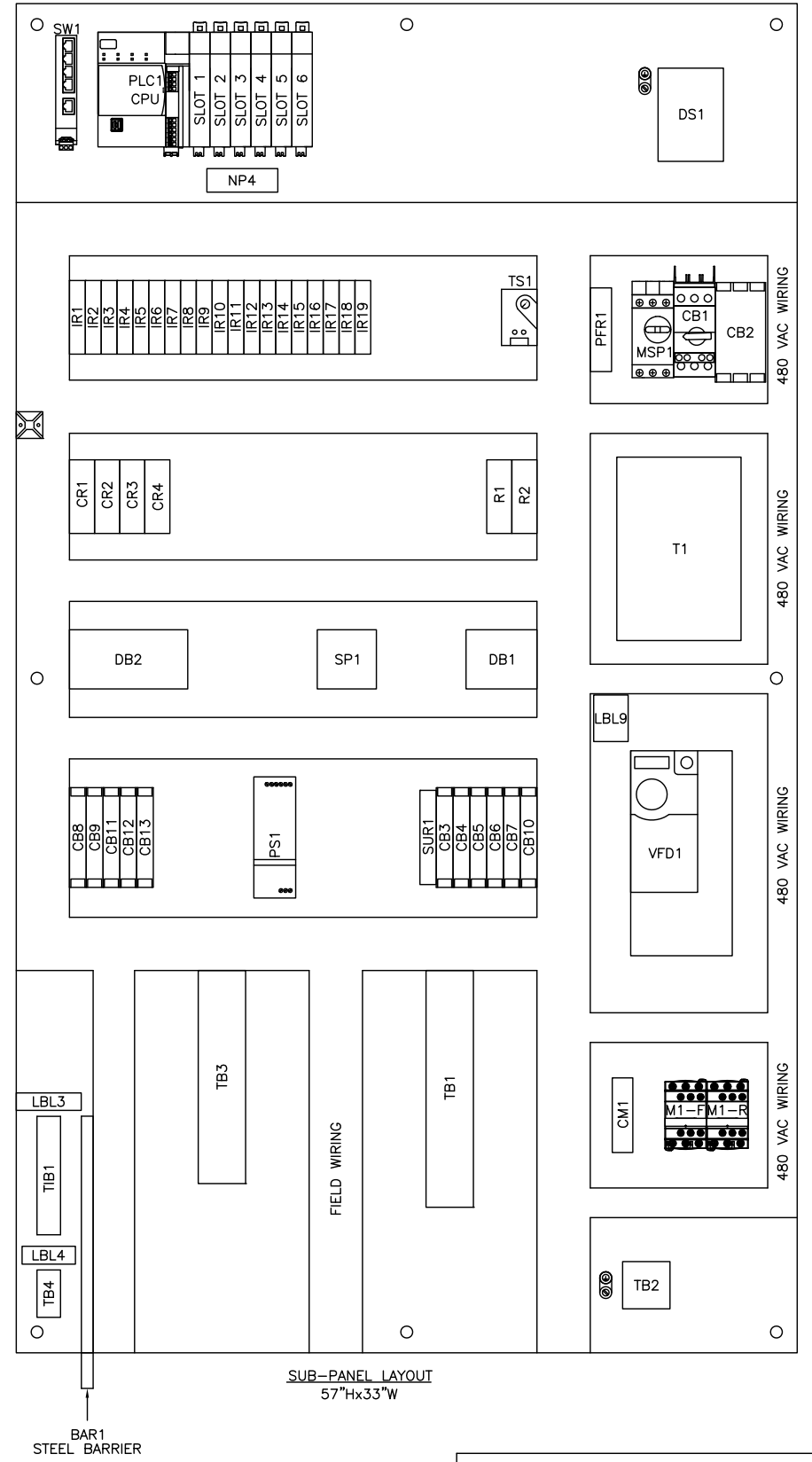
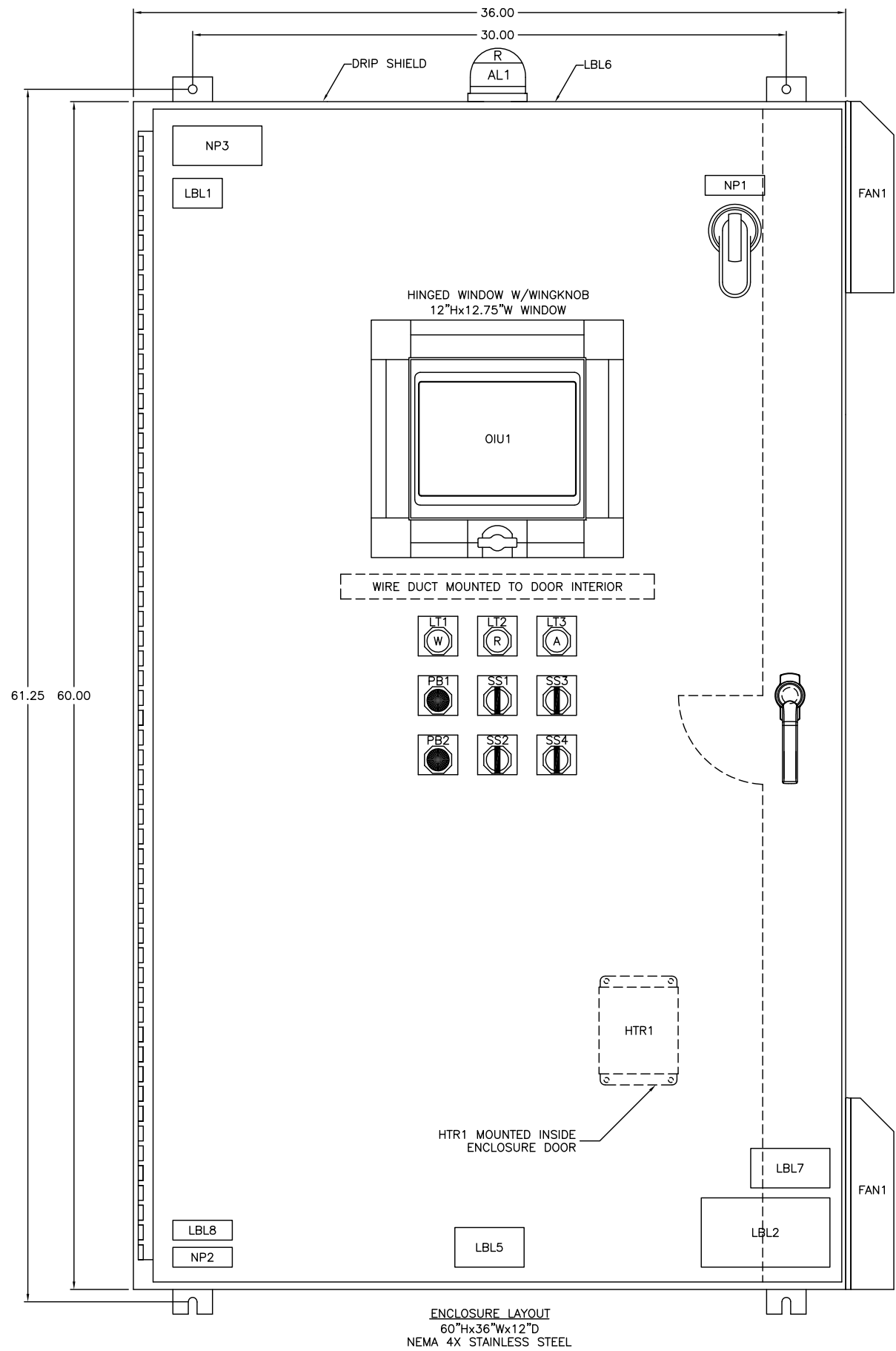
ALL DEWATERING EQUIPMENT WILL STOP IMMEDIATELY IF THE E–STOP PUSHBUTTON IS ACTIVATED. THE DEWATERING SYSTEM WILL NOT RESUME OPERATION UNTIL THE E–STOP IS RESET AND THE SYSTEM RESET PUSHBUTTON IS PRESSED.

OIU – INFORMATION:

1. THE OIU WILL DISPLAY THE ELAPSED MOTOR RUN TIMES.
2. ALL ADJUSTABLE SETPOINTS CAN BE ACCESSED AND ADJUSTED THROUGH THE OIU.
3. THE PRESENT FAULT WILL BE DISPLAYED ON THE OIU.
4. THE HISTORY OF ALL PAST FAULTS CAN BE ACCESSED THROUGH THE OIU.
5. FLOW INDICATION AND AMOUNT SHALL BE DISPLAYED ON THE OIU.
6. RUNNING AND FAULTED STATUS FOR ALL MOTORS AND PUMPS WILL BE DISPLAYED ON THE OIU.
7. VFD SPEEDS MAY BE ADJUSTED THROUGH THE OIU.
8. THE PRESS MOTOR TORQUE WILL BE DISPLAYED ON THE OIU.
9. THE PRESS MINIMUM AND MAXIMUM SPEED RANGE WILL BE DISPLAYED ON THE OIU.
10. THE ALARM HISTORY WILL DISPLAY THE PEAK VALUE OF TORQUE MEASURED WHEN A TORQUE OVERLOAD FAULT OCCURS.

						DESIGNED	JN
						DETAILED	
						CHECKED	MSN
						APPROVED	
DATE		REVISION		NO.	BY	CK	APP DATE
							11/09/23

 <p>1009 Airlie Parkway Denver, NC 28037 Tel. 704-949-1010 info@hhusa.net</p>		Q–PRESS CONTROL PANEL	
		MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851		DRAWING NO: HBR9464A15	
		15 OF 17	



DATE	REVISION	NO.	BY	CK	APP	DATE

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1009 Airlie Parkway
Denver, NC 28037
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Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI

SCALE: NONE

PROJECT NUMBER: 73010851

DRAWING NO: HBR9464A16

16 OF 17

PILOT DEVICE LEGENDPLATES (PANEL DOOR)				
DEVICE TAG	DESCRIPTOR LINE 1	DESCRIPTOR LINE 2	DESCRIPTOR LINE 3	
LT1	CONTROL POWER	ON		
LT2	DEWATERING	MODE		
LT3	SYSTEM	DISTURBANCE		
PB1	EMERGENCY	STOP		
PB2	SYSTEM	RESET		
SS1	PRESS	OFF	HAND	AUTO
SS2	PRESS	OFF	FOR	REV
SS3	SPRAY WASH	OFF	HAND	AUTO
SS4	SPRAY DRIVE	OFF	HAND	AUTO
MAX. CHARACTERS	15	15	4	4

LABEL DESCRIPTION	
LBL1	WARNING MULTIPLE SUPPLY SOURCES OPEN ALL DISCONNECTS BEFORE SERVICING EQUIPMENT OR OTHER UNIT WIRING
LBL2	DANGER HIGH VOLTAGE ENTRY BY QUALIFIED PERSON ONLY
LBL3	WARNING SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY
LBL4	INTRINSICALLY SAFE FIELD WIRING TERMINALS
LBL5	ELEMECH ELECTRICAL CONTROL SYSTEMS
LBL6	WARNING DAMAGE RESULTING FROM INSTALLATION OF TOP ENTRY CONDUIT WILL VOID WARRANTY. - AVOID CUTTING HOLES DIRECTLY ABOVE ANY ELECTRICAL COMPONENTS - PROTECT INTERNAL COMPONENTS FROM METAL SHAVINGS, CUTTING OILS, DEBRIS, AND MOISTURE - USE PROPER FITTINGS, MYERS TYPE 4 OR EQUAL - CONDUITS AND FITTING MUST BE WATERTIGHT TO PREVENT WATER ENTRY - ALL PENETRATIONS MUST BE SEALED OFF TO PREVENT INTRUSION OF MOISTURE, CORROSIVE GASES, AND VAPORS FROM ENTERING THE ENCLOSURE
LBL7	DANGER ARC FLASH AND SHOCK HAZARD FOLLOW ALL REQUIREMENTS NFPA 70E FOR SAFE WORK PRACTICES AND FOR PERSONAL PROTECTIVE EQUIPMENT.
LBL8	WARNING TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.
LBL9	VFD SETUP GUIDE

NAMEPLATES			
TAG	DESCRIPTOR LINE 1	DESCRIPTOR LINE 2	DESCRIPTOR LINE 3
NP1	480VAC-3PH-60HZ		
NP2	INTRINSICALLY	SAFE CIRCUITS	
NP3	CONTROL PANEL PROVIDES INTRINSICALLY SAFE CIRCUIT EXTENSIONS FOR USE IN CLASS I, DIVISION 1 GROUPS A,B,C,D; CLASS I, ZONE 0 AND 1, GROUP IIC; CLASS II, DIVISION 1 GROUPS E,F,G HAZARDOUS LOCATIONS WHEN CONNECTED PER PR ELECTRONICS INSTALLATION DRAWING NO. 5202QU01		
NP4	WARNING! TO AVOID DAMAGING ANY INPUT OR OUTPUT MODULE, VERIFY THE SA POWER REQUIREMENT OF EACH MODULE BEFORE POWER UP. MODULES MUST BE INSTALLED TO THE RIGHT OF THE CORRECT SA POWER SOURCE TO AVOID DAMAGE.		

NAMEPLATES AND LEGENDPLATES CONSTRUCTION					
	PANEL LEGENDPLATES	LCS LEGENDPLATES	NAMEPLATES	UL698 NAMEPLATES	DEVICE TAGS
TEXT COLOR	BLACK	BLACK	BLACK	BLACK	BLACK
BACKGROUND COLOR	WHITE/ YELLOW (E-STOPS)	WHITE/ YELLOW (E-STOPS)	WHITE	YELLOW	WHITE
MATERIAL	THERMAL TRANSFER	THERMAL TRANSFER	THERMAL TRANSFER	PHENOLIC ENGRAVED	THERMAL TRANSFER
ATTACHMENT	ADHESIVE	ADHESIVE	ADHESIVE	ADHESIVE	ADHESIVE
TEXT SIZE	5/32" HIGH	5/32" HIGH	3/16" HIGH	1/8" HIGH	1/8" HIGH
DIMENSIONS	2.375"x2.375"	1.875"x1.875"	2.72"x1"	4"x2"	1"x1/2"
MAX. CHARACTERS PER LINE	15	15	17	35	7

PANEL DATA LABEL



ELEMECHINC.COM 630-499-7080

WARRANTY NOTICE
NO ALLOWANCE OR PAYMENT WILL BE MADE FOR WARRANTY REPAIR UNLESS PRIOR AUTHORIZATION HAS BEEN REQUESTED AND OBTAINED FROM THE ELEMECH SERVICE DEPT.

SERIAL: HBR9464 POWER: 3/60/480
REF: # 73010851 FLA: 9.2A
DATE: TBD LGST MOT: 7.1A

SHORT CIRCUIT CURRENT RATING
5 KA RMS SYMMETRICAL @ 480 VOLTS MAX

ENCLOSURE RATING: NEMA TYPE 4X

NAME: MT. CLEMENS, MI

CIRCUIT 2-16: 10A @ 120VAC

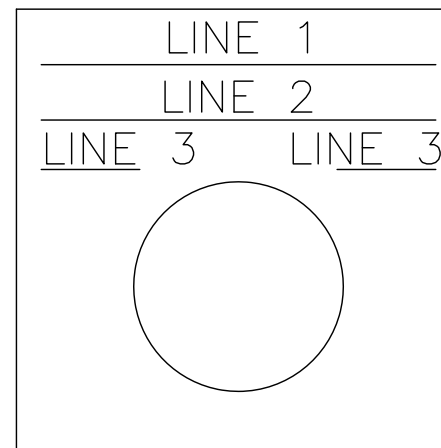
TORQUE SCREWS TO 12 IN-LBS

ALL FIELD WIRING SHALL BE 60°C COPPER CONDUCTOR ONLY

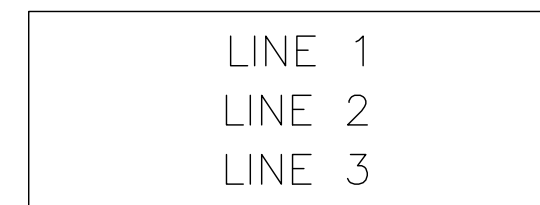
NOTE:
THE CONTROL PANEL WILL ALSO BE LISTED AND LABELED WITH A SERIALIZED LABEL AS OUTLINED IN THE CONTROL PANEL SPECIFICATION NOTES.

REPLACE TBF WITH FAST ACTING FUSE RATED AT 250V, MAX 1 AMP BUSSMAN AGC-1 OR EQUAL

PILOT DEVICE LEGENDPLATES



PANEL NAMEPLATE



DEVICE TAG



NOTE:
TEXT WILL REMAIN VERTICALLY CENTERED IF LESS THAN 3 LINES ARE USED.

DESIGNED	JN
DETAILED	
CHECKED	MSN
APPROVED	
DATE	11/09/23
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BY	
CK	
APP	
DATE	

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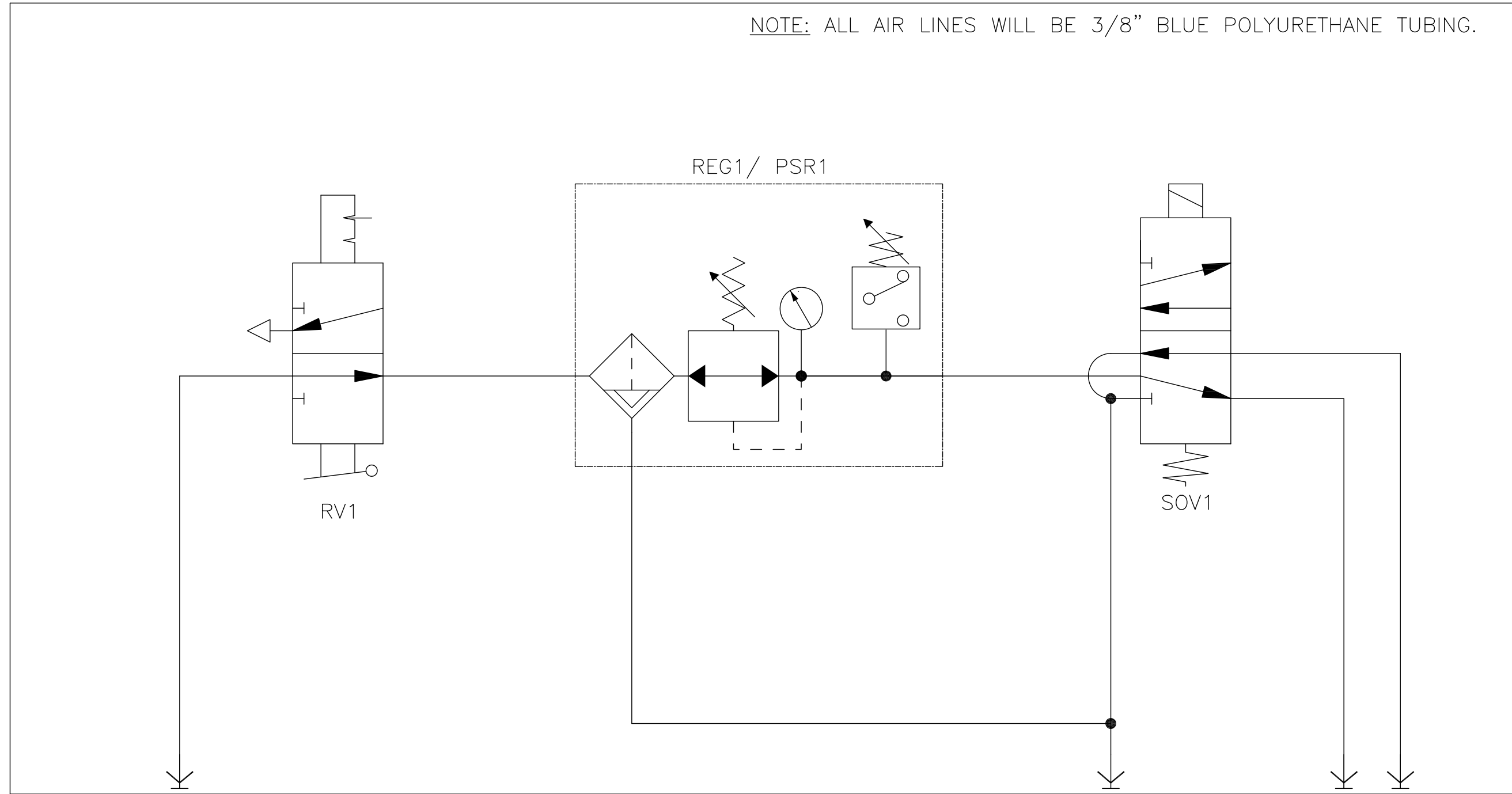
Q-PRESS
CONTROL PANEL

MT. CLEMENS, MI SCALE: NONE

PROJECT NUMBER: 73010851 DRAWING NO: HBR9464A17
17 OF 17

PNEUMATIC
CONTROL PANEL

NOTE: ALL AIR LINES WILL BE 3/8" BLUE POLYURETHANE TUBING.



AIR SUPPLY
CONNECTION
STAINLESS STEEL
BULKHEAD
3/8"OD TUBE FITTING

DRAIN / EXHAUST
CONNECTION
STAINLESS STEEL
BULKHEAD
3/8"OD TUBE FITTING

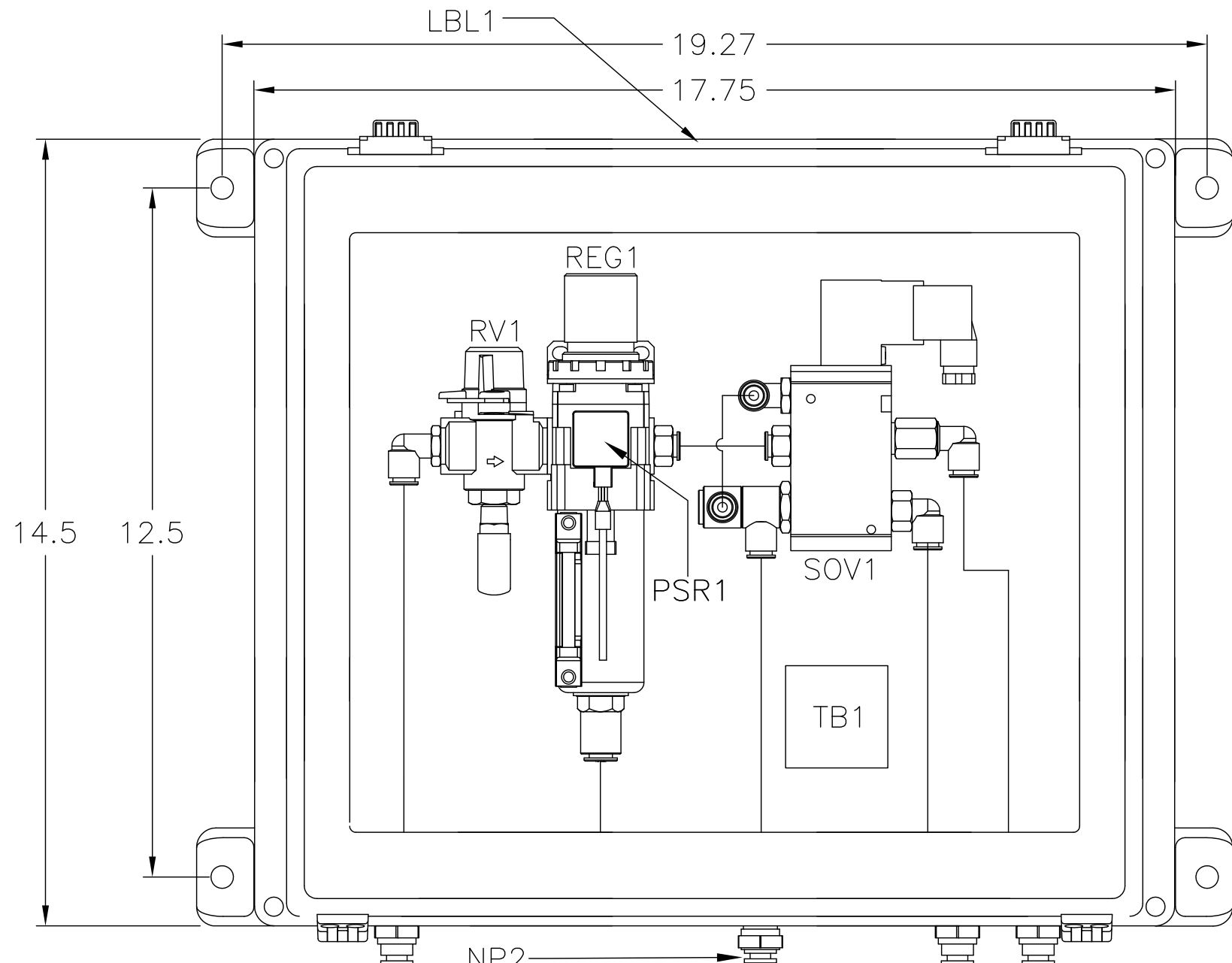
CONTROL
CONNECTION
STAINLESS STEEL
BULKHEAD
3/8"OD TUBE FITTING

CONTROL
CONNECTION
STAINLESS STEEL
BULKHEAD
3/8"OD TUBE FITTING

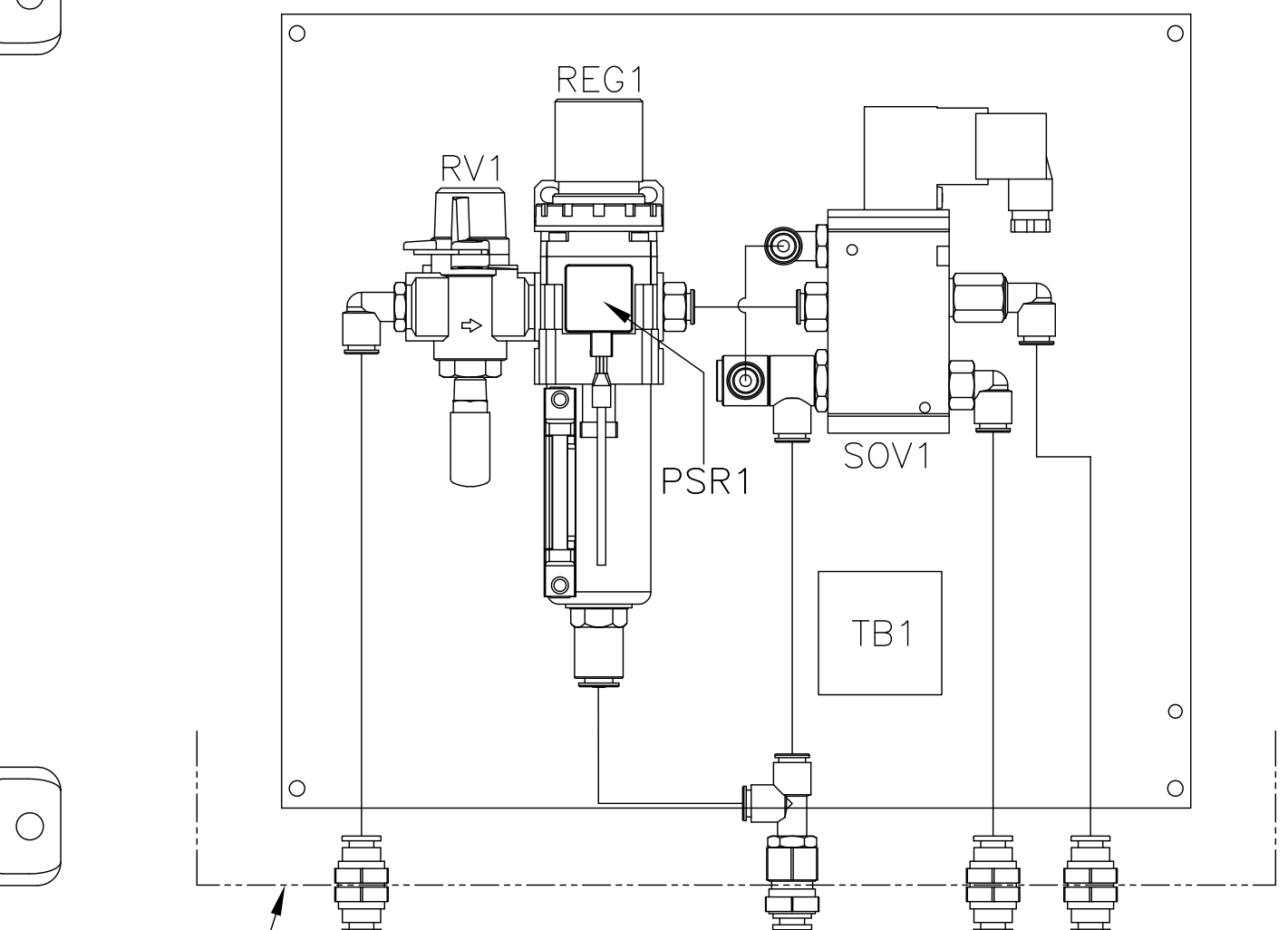
DESIGNED	JN			
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CHECKED	MSN			
APPROVED				
DATE	11/09/23			
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Denver, NC 28037
Tel. 704-949-1010
info@hhusa.net

Q-PRESS PNEUMATIC CONTROL PANEL	
MT. CLEMENS, MI	SCALE: NONE
PROJECT NUMBER: 73010851	DRAWING NO: HBR9464B02
	2 OF 3



ENCLOSURE LAYOUT
 18"Hx14"Wx9"D NEMA 4X FIBERGLASS WINDOW
 14.45"Hx11.06"W



SUB-PANEL LAYOUT
 14.75"Hx12.88"W

LEGEND:
 NP1 - AIR SUPPLY CONNECTION
 NP2 - DRAIN CONNECTION
 NP3 - CONTROL CONNECTION
 NP4 - CONTROL CONNECTION

LBL1 - WARNING
 DAMAGE RESULTING FROM
 INSTALLATION OF TOP ENTRY
 CONDUIT WILL VOID WARRANTY
 - USE PROPER FITTINGS, MEYERS
 TYPE 4 OR EQUAL
 - PROTECT INTERIOR DEVICES
 FROM INSTALLATION DEBRIS
 - CONDUIT MUST BE SEALED
 WATERTIGHT TO PREVENT WATER
 ENTRY

DATE	REVISION	NO.	BY	CK	APP	DATE

DESIGNED	JN
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CHECKED	MSN
APPROVED	
	11/09/23

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 1009 Airlie Parkway
 Denver, NC 28037
 Tel. 704-949-1010
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Q-PRESS PNEUMATIC
 CONTROL PANEL
 MT. CLEMENS, MI
 SCALE: NONE
 PROJECT NUMBER: 73010851
 DRAWING NO: HBR9464B03
 3 OF 3

Bill of Materials



Rev: 0

Date: 11-21-2023

Section:

D

Section Name:

Bill of Materials

By: JN

Job Number:

HBR9464

Page #

1/1

Item	Component	Description	Manufacturer Part Number	QTY	Device
Q-Press - Main Control Panel (Quantity: 2)					
1	00-000-000	Wire, Hardware, Wire labels, etc.		2	
2	10-069-000	Wireway Duct Cover, 1.5"W, 6 Ft. Section, w/Panduit F Series	Panduit: C1.5WH6	6	
3	10-069-001	Wireway Duct Cover, 1"W, 6 Ft. Section, w/Panduit F Series	Panduit: C1WH6	6	
4	10-069-002	Wireway Duct Cover, 2"W, 6 Ft. Section, w/Panduit F Series	Panduit: C2WH6	9	
5	10-069-005	Wireway Duct, 1.5"Wx3"H, 6 Foot Section	Panduit: F1.5X3WH6	6	
6	10-069-007	Wireway Duct, 1"Wx3"H, 6 Foot Section	Panduit: F1X3WH6	6	
7	10-069-008	Wireway Duct, 2"Wx3"H, 6 Foot Section	Panduit: F2X3WH6	9	
8	25-000-A001	Legendplate Assembly, Yellow E-Stop, Standard Encl.	EleMech: 25-000-A001 Assembly	1	
9	25-000-A002	Legendplate Assembly, White, Black Text, Standard Encl.	EleMech: 25-000-A002 Assembly	8	
10	25-000-A019	Nameplate Assembly, White: Power Supply - 3/60/480VAC	EleMech: 25-000-A019 Assembly	1	
11	42-063-007	Terminal Block, Din Rail, 35MM Wide, 15 High, 2 Meters Long	Iboco: Omega 3 AF	2	
12	51-000-062	Wire, MTW Type, 600V, 105°C, CSA/UL1015, Tinned Copper	EleMech: 51-000-062	1	
13	52-000-003	Label, Underwriters Laboratories 698A, w/Decal Set	EleMech: 698A	1	
14	56-097-005	Beacon, Steady/Strobe, LED, NEMA 4X, 24VDC, Red, 1/2"Male -NS	Federal: LP22LED-012-024R	1	AL1
15	18-000-002	Steel Barrier, 14Ga., 0.5"Wx10.0"x6.0"D, Standard	EleMech: 18-000-002	1	BAR1
16	23-005-047	Motor Starter Protector, 3PH, 600V, 14.5-20 Amp Range, D/FRM	Allen-Bradley: 140MT-D9E-C20	1	CB1
17	23-005-050	Motor Starter Protector, Line Terminal Adapter, w/140MT-C,D	Allen-Bradley: 140MT-C-TE	1	CB1
18	03-058-153	Circuit Breaker, 3 Pole, 480VAC, 8A, 10kA, UL489, Type D	Square D: M9F43308	1	CB2
19	03-058-125	Circuit Breaker, 1 Pole, 240VAC, 10A, 14kA, UL489, Type C	Square D: M9F42110	1	CB3
20	03-058-123	Circuit Breaker, 1 Pole, 240VAC, 6A, 14kA, UL489, Type C	Square D: M9F42106	2	CB4,5
21	03-058-119	Circuit Breaker, 1 Pole, 240VAC, 2A, 14kA, UL489, Type C	Square D: M9F42102	8	CB6-13
22	57-000-A030	Cable, Comm., Ethernet, CAT5e, 600V, RJ45M to RJ45M,Shielded	EleMech: 57-000-A030	2	CBL1,2
23	57-009-008	Cable, Comm., Ethernet, Cat. 5, 600V,4 PAIR, 24AWG, 6.6 FT	Belden: E505002-010S1	1	CBL3
24	04-094-000	Current Monitor, Selectable, SPDT, 120/24V ,2-100A, w/Delay	Gavazzi: DIB01CM24100A	1	CM1
25	06-058-012	Control Relay, Bus Jumper, 2-Pole, w/Telemec. RXM Relay	Square D: RXZ S2	3	CR1-4
26	06-058-015	Control Relay, 3PDT,24VDC, 11Pin Spade, Indicator, Operator	Square D: RXM3AB2BD	4	CR1-4
27	38-058-003	Socket, 11 Pin Spade, Din, Screw Term., 3Tier, 250V w/3-Pole	Square D: RXZE2S111M	4	CR1-4
28	07-063-000	Distribution Block, End Cover, 4 Pole, 300V,10A, w/WK4E\U\VB	Wieland: 07.311.4053.1	2	DB
29	07-063-001	Distribution Block, Jumper, 4 Pole, 300V,10A, w/WK4E\U\VB	Wieland: Z7.210.3427	6	DB

Item	Component	Description	Manufacturer Part Number	QTY	Device
30	07-063-002	Distribution Block, Single Pole, 10A, 300V, WK4E\U\VB	Wieland: 57.404.6955.1	20	DB
31	09-001-A030	Disconnect Assembly, Non-Fused, 60 Amp, NEMA 4X, 12" Depth	ABB: OT60F3 Assembly	1	DS1
32	11-000-340	Enclosure Drip Shield, Stainless Steel, Per Inch	EleMech: 11-000-340	36	EN1
33	11-000-A042	Wind Kit, Alum/Hinge, Wing Knob w/out Frame, 12.75"H x 12"W	EleMech: 11-000-A042	1	EN1
34	11-035-143	Sub-Panel, Painted Steel, w/60"Hx36"W C. Hinge Encl	Hoffman: A-60P36	1	EN1
35	11-035-451	Enclosure, Nema 4X, 304SS, 60"Hx36"Wx12"D, C. Hinge, 3-PT	Hoffman: A-60H3612SSLP3PT	1	EN1
36	11-182-010	Enclosure Filter Fan, 39CFM w/Filter, 115VAC, NEMA 12, 6"	Rittal: 3238110	1	FAN1
37	11-182-011	Enclosure Filter Fan Hoseproof hood, NEMA 4X, w/ 3238 series	Rittal: 3238080	2	FAN1
38	11-182-012	Enclosure Filter Fan, Outlet Filter	Rittal: 3238200	1	FAN1
39	15-011-000	Ground Lug, 14AWG - 4AWG	Blackburn: L70	2	GND
40	17-035-002	Heater, 100 Watts, 120VAC, w/Thermostat and Fan	Hoffman: D-AH1001A	1	HTR1
41	52-137-003	Label, Caution: Heater Element, 1.5"Wx0.75"H, White/Red	Nameplate Tech: 52-137-003	1	HTR1
42	06-058-027	Control Relay Retension Clip, w/Telemec. RPM 1-Pole Relay	Square D: RPZR235	19	IR1-19
43	06-058-028	Control Relay, SPDT, 24VDC, 5Pin Spade, Operator, 15A	Square D: RPM12BD	19	IR1-19
44	06-058-040	Diode, 6-250VDC, w/ RXM Sockets, RPZF1/2 Sockets	Square D: RXM040W	19	IR1-19
45	38-058-009	Socket, 5 Pin Spade, Din Mount, Screw Term., w/ RPM 1-Pole	Square D: RPZF1	19	IR1-19
46	52-137-002	Label, Multiple Supply Sources, Warning, 2.5"Wx1.5"H, Yellow	Nameplate Tech: 52-137-002	1	LBL1
47	52-137-001	Label, High Voltage, Danger, 6.5"Wx3.5"H, White/Black/Red	Nameplate Tech: 52-137-001	1	LBL2
48	32-005-A005	Pilot light, NEMA 4X, Universal, LED, White	Allen-Bradley: 800H-QRH2W	1	LT1
49	32-005-A007	Pilot light, NEMA 4X, Universal, LED, Red	Allen-Bradley: 800H-QRH2R	1	LT2
50	32-005-A008	Pilot light, NEMA 4X, Universal, LED, Amber	Allen-Bradley: 800H-QRH2A	1	LT3
51	22-058-003	Contact, 3PH, Reversing, 9 Amp, 1NO/1NC Aux., 120VAC Coil	Square D: LC2D09G7	1	M1-F/R
52	22-058-008	Aux. Contact, Top mounted, 1NO/1NC, w/Square D LC/T0 Series	Square D: LADN11	1	M1-F/R
53	23-058-003	Motor Starter Protector, Aux., 1NO-1NC, F-Mnt, w/GV2/3	Square D: GVAE11	1	MSP1
54	23-058-005	Motor Starter Protector, 3PH, 600V, 0.63-1.0 Amp Range, 508E	Square D: GV2P05	1	MSP1
55	23-058-011	Motor Starter Protector, Line Insulator, 508E	Square D: GV2GH7	1	MSP1
56	25-000-A010	Nameplate Assembly, White, Black Text, 1"Hx3"W	EleMech: 25-000-A010 Assembly	3	NP1,2,4
57	25-000-A058	Nameplate Assembly, Yellow: Intrinsically Safe Circ: PR5202	EleMech: 25-000-A058 Assembly	1	NP3
58	26-005-088	OIU, PVP 7 Standard, 7" Display, 24VDC, Touch, Ethernet	Allen Bradley: 2711P-T7C21D8S	1	OIU1
59	HBR-170-P022	Program, OIU, PVP 7 6/7", Standard w/cplgx	EleMech: HBR-170-P022	1	OIU1

Item	Component	Description	Manufacturer Part Number	QTY	Device
60	29-005-117	Pushbutton, E-Stop, NEMA 4X, Oper+1NC, Twist Rel. Red Head	Allen-Bradley: 800H-TFRXT6D2	1	PB1
61	29-005-002	Pushbutton, NEMA 4X, Oper+1NO, Flush Head, Black	Allen-Bradley: 800H-AR2D1	1	PB2
62	30-183-000	Phase Failure, Voltage Monitoring Relay,380-480VAC, 2 SPDT	Telemecanique: RM22TR33	1	PFR1
63	33-005-277	Compact 5069, Discrete Out., (16) 120AC/24DC Relay, 24VDC SA	Allen-Bradley: 5069-OW16	2	PLC1
64	33-005-278	Compact 5069, Analog Input, 4 Chnl., 24V SA Power	Allen-Bradley: 5069-IY4	1	PLC1
65	33-005-280	Compact 5069, Term Block, 18 Pin, Screw Clamp, w/ I/O	Allen-Bradley: 5069-RTB18-SCREW	6	PLC1
66	33-005-282	Compact 5069, Term. Block, 6 Pin/4 Pin, Screw Clamp, w/CPU	Allen-Bradley: 5069-RTB64-SCREW	1	PLC1
67	33-005-336	Compact 5069, CPU 0.6MB Mem, SD, 2-Ether, 8 Cards, 24VDC	Allen-Bradley: 5069-L306ER	1	PLC1
68	33-005-338	Compact 5069, Analog Output, 4 Chnl., 24V SA Power	Allen-Bradley: 5069-OF4	1	PLC1
69	33-005-347	Compact 5069, Discrete Input , (16) 24VDC Inputs, 24V SA	Allen-Bradley: 5069-IB16	2	PLC1
70	HBR-170-P008	Program, PLC, Compact Logix, Standard	EleMech: HBR-170-P008	1	PLC1
71	37-098-018	Power Supply, 240W, 85-264VAC IN, 24VDC OUT, UNO Series	Phoenix: 1096432	1	PS1
72	06-058-021	Control Relay, DPDT,120VAC, 8Pin Spade, Operator, 15A	Square D: RPM22F7	2	R1,2
73	38-058-008	Socket, 8 Pin Spade, Din Mount, Screw Term., w/ RPM 2-Pole	Square D: RPZF2	2	R1,2
74	13-000-A000	Spare Parts Box Assembly, Din Rail Mount	EleMech: 13-000-A000 Assembly	1	SP1
75	39-005-009	Selector Switch, NEMA 4X, 3 Pos. Maintained, 1NO-1NC	Allen-Bradley: 800H-JR2A	3	SS1,3,4
76	39-005-011	Selector Switch, Nema 4X, 3 Pos. Spring Fr. Right, 1NO-1NC	Allen-Bradley: 800H-JR5A	1	SS2
77	40-030-002	Surge Suppressor, 1 Pole, 120VAC, 200kA SCCR, DIN	Mersen: STP120P07	1	SUR1
78	33-098-028	Ethernet Switch, 5TX, 9-32VDC, RJ45, 5 Port, 10/100, Narrow	Phoenix: 1085039	1	SW1
79	41-018-028	Control Transformer, Secondary Fuse Cover, w/C Series	Cutler-Hammer: FSK6	1	T1
80	41-018-038	Control Transformer, 480/240-120VAC, 750VA, 1PH	Cutler-Hammer: C0750E2A	1	T1
81	42-063-001	Terminal Block, End Plate, Gray, w/WK4/U	Wieland: 07.311.0155.0	4	TB
82	42-063-003	Terminal Block, Single Pole Gray, 30A, 600V, 6MM Wide, WK4/U	Wieland: 57.504.0055.0	87	TB
83	42-063-015	Terminal Block, Jumper, w/WK4/U, 02 pole, Insulated	Wieland: Z7.281.1227	2	TB
84	42-063-000	Terminal Block, Labels, Custom Printed, w/WK4/U	Wieland: 04.242.6353-CUSTOM	124	TB,DB
85	42-063-004	Terminal Block, Ground, 30A, 600V, 6MM Wide, w/WK4/U	Wieland: 57.504.9055.0	10	TB,DB
86	42-063-009	Terminal Block, End Clamp, w/WKN10/U	Wieland: Z5.522.8553	14	TB,DB
87	42-063-008	Terminal Block, Labels, Blank, w/WK4/U-(600 tags per box)	Wieland: Z4.242.6353	30	TB1
88	13-012-034	Fuse, Glass, Fast Acting, 250VAC, 1A, 6.3mm	Bussman: AGC-1	5	TB3F
89	42-063-073	Terminal Block, Fuse Base, Single Pole, Gray, WK4 TKG	Wieland: 57.504.4055.0	5	TB3F

Item	Component	Description	Manufacturer Part Number	QTY	Device
90	42-063-074	Terminal Block, Fuse Insert, 6.3mm Fuse,12-24V LED, WK4 TKG	Wieland: Z1.298.1753.0	5	TB3F
91	18-247-001	Transformer Isolated Barrier, Dual Channel, 120VAC/24VDC	PR Electronics: 5202B2	1	TIB1
92	46-034-004	Thermostat, for fan control, N.O.contact, 6 amp,30-140 F.	Stego: 11101.9-00	1	TS1
93	52-000-068	Label, PowerFlex 525, Video QR Code	EleMech: 52-000-068	1	VFD
94	HBR-170-P019	Program, VFD, PowerFlex 525, Standard	EleMech: HBR-170-P019	1	VFD
95	50-005-083	Variable Freq. Drive, Open, 7.5HP, 480VAC, 3PH, Powerflex525	Allen-Bradley: 25B-D013N104	1	VFD1
Q-Press Pressure Cone Pneumatic Panel (Standard) (Quantity: 2)					
96	51-000-062	Wire, MTW Type, 600V, 105°C, CSA/UL1015, Tinned Copper	EleMech: 51-000-062	1	
97	94-255-009	Tubing, 3/8"OD, Polyurethane, Blue, 100 Foot Roll	SMC USA: TIUB11BU-33	1	
98	94-255-008	Fitting, Bulkhead, Union, SS, w/ 3/8"OD Tube x 3/8"OD Tube	SMC USA: KQG2E11-00	3	BU1,3,4
99	94-255-042	Fitting, Bulkhead Union Connector 3/8"OD Tubex3/8"NPT 316SS	SMC USA: KQG2E11-N03	1	BU2
100	11-035-129	Sub-Panel, Painted Steel, w/16"Hx14"W Junction Box	Hoffman: A-16P14	1	EN1
101	11-035-176	Enclosure Mounting Feet, Fiberglass, J box	Hoffman: A-50MFKR	1	EN1
102	11-035-338	Enclosure, Nema 4X, Fiberglass, 17.5"Hx14"Wx8.78"D, w/Window	Hoffman: A-18149JFGQRPWR	1	EN1
103	94-255-005	Fitting, Male Connector, Straight, 3/8"OD Tube x 3/8"MNPT	SMC USA: KQ2H11-36AS	2	FIT
104	94-255-006	Fitting, Male Elbow, 3/8"OD Tube x 3/8"MNPT	SMC USA: KQ2L11-36AS	2	FIT
105	94-255-015	Fitting, Male Elbow, Extended, 3/8" OD Tube x 3/8" MNPT	SMC USA: KQ2W11-36AS	1	FIT
106	94-255-020	Fitting, Male Run Tee, 3/8"OD x 3/8" OD x 3/8" NPT	SMC USA: KQ2Y11-36AS	1	FIT
107	94-255-048	Fitting, Male Double Rotating Elbow, 3/8"OD Tube x 1/4"MNPT	SMC USA: KQ2VD11-35AS	1	FIT
108	94-255-049	Fitting, Male Elbow, 3/8"OD Tube x 1/4"MNPT	SMC USA: KQ2L11-35AS	1	FIT
109	94-255-004	Regulator, 0-120PSI, 3/8"NPT, w/ Filter and pressure switch	SMC USA: AW30-NO3BDE3-8Z	1	REG1
110	74-255-004	Solenoid Valve, Muffler, 1/4" NPT Port, 30 dB Reduction	SMC USA: AN20-NO2	1	RV1
111	94-255-016	Relief Valve, 3-Port, Locking Holes, 3/8"NPT	SMC USA: VHS30-N03-Z	1	RV1
112	94-255-017	Relief Valve, Spacer, w/ Bracket	SMC USA: Y300T	1	RV1
113	74-255-006	Solenoid Valve, 2 Pos, Single, (3) 3/8"/(2) 1/4" NPT, 120VAC	SMC USA: VFS3120-3DZ-03T	1	SOV1
114	94-215-004	Fitting, Tube Connector, Straight, 3/8" OD x 10mm OD	McMaster-Carr: 5779K259	2	SPARE
115	42-063-000	Terminal Block, Labels, Custom Printed, w/WK4/U	Wieland: 04.242.6353-CUSTOM	12	TB1
116	42-063-001	Terminal Block, End Plate, Gray, w/WK4/U	Wieland: 07.311.0155.0	1	TB1
117	42-063-003	Terminal Block, Single Pole Gray, 30A, 600V, 6MM Wide, WK4/U	Wieland: 57.504.0055.0	5	TB1
118	42-063-004	Terminal Block, Ground, 30A, 600V, 6MM Wide, w/WK4/U	Wieland: 57.504.9055.0	1	TB1

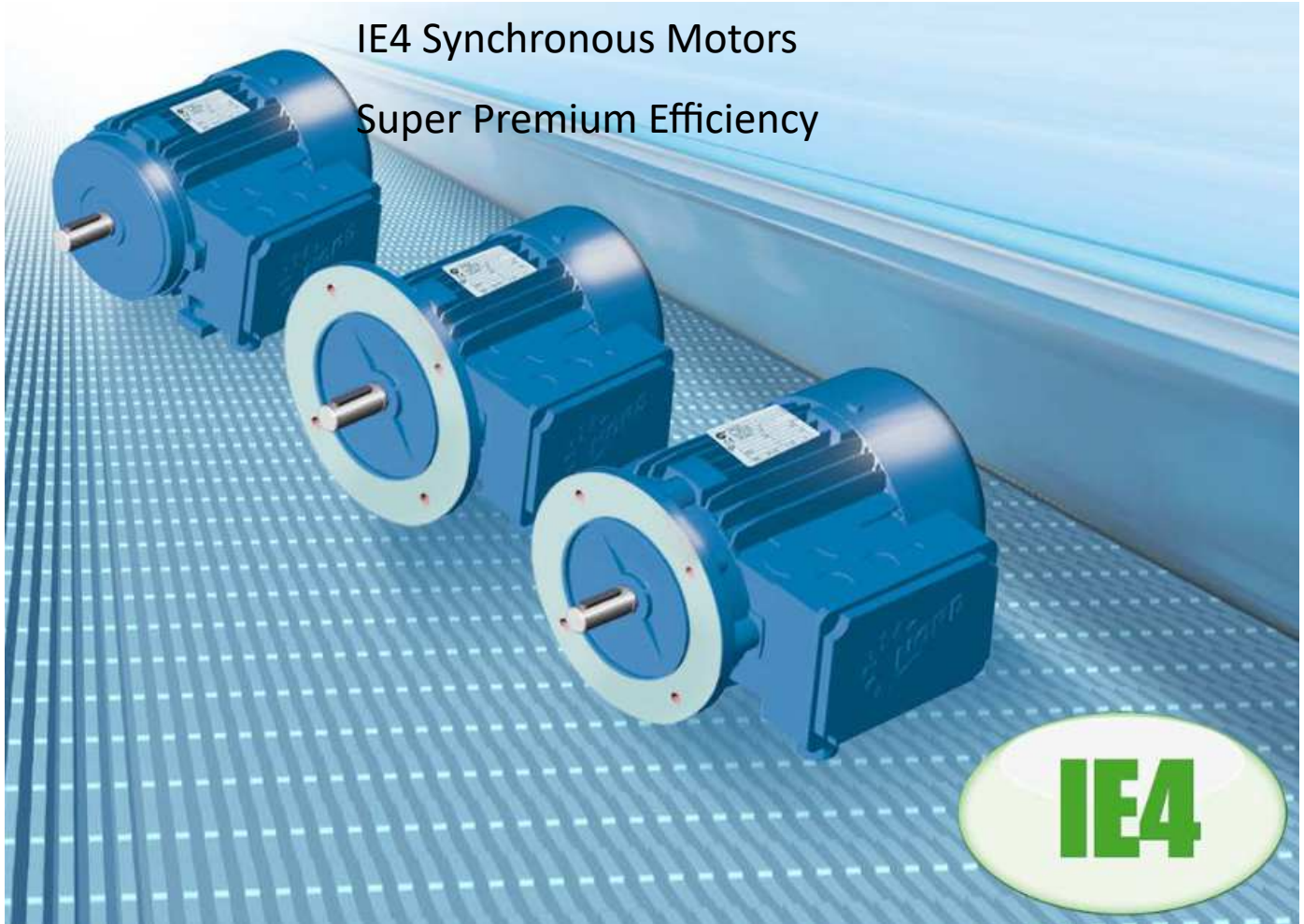
Item	Component	Description	Manufacturer Part Number	QTY	Device
119	42-063-007	Terminal Block, Din Rail, 35MM Wide, 15 High, 2 Meters Long	Iboco: Omega 3 AF	1	TB1
120	42-063-009	Terminal Block, End Clamp, w/WKN10/U	Wieland: Z5.522.8553	2	TB1
Spare Parts / Ship Loose (Total Quantity Provided)					
121	13-012-034	Fuse, Glass, Fast Acting, 250VAC, 1A, 6.3mm	Bussman: AGC-1	10	SPARE
122	61-000-012	Labor, Engineering, Submittal, Schematics, BOM	EleMech: 61-000-012	1	ENG

SECTION 7
TECHNICAL SPECIFICATIONS

APPENDIX INFORMATION

SK 100T5/4 TF

IE4 Synchronous Motors
Super Premium Efficiency



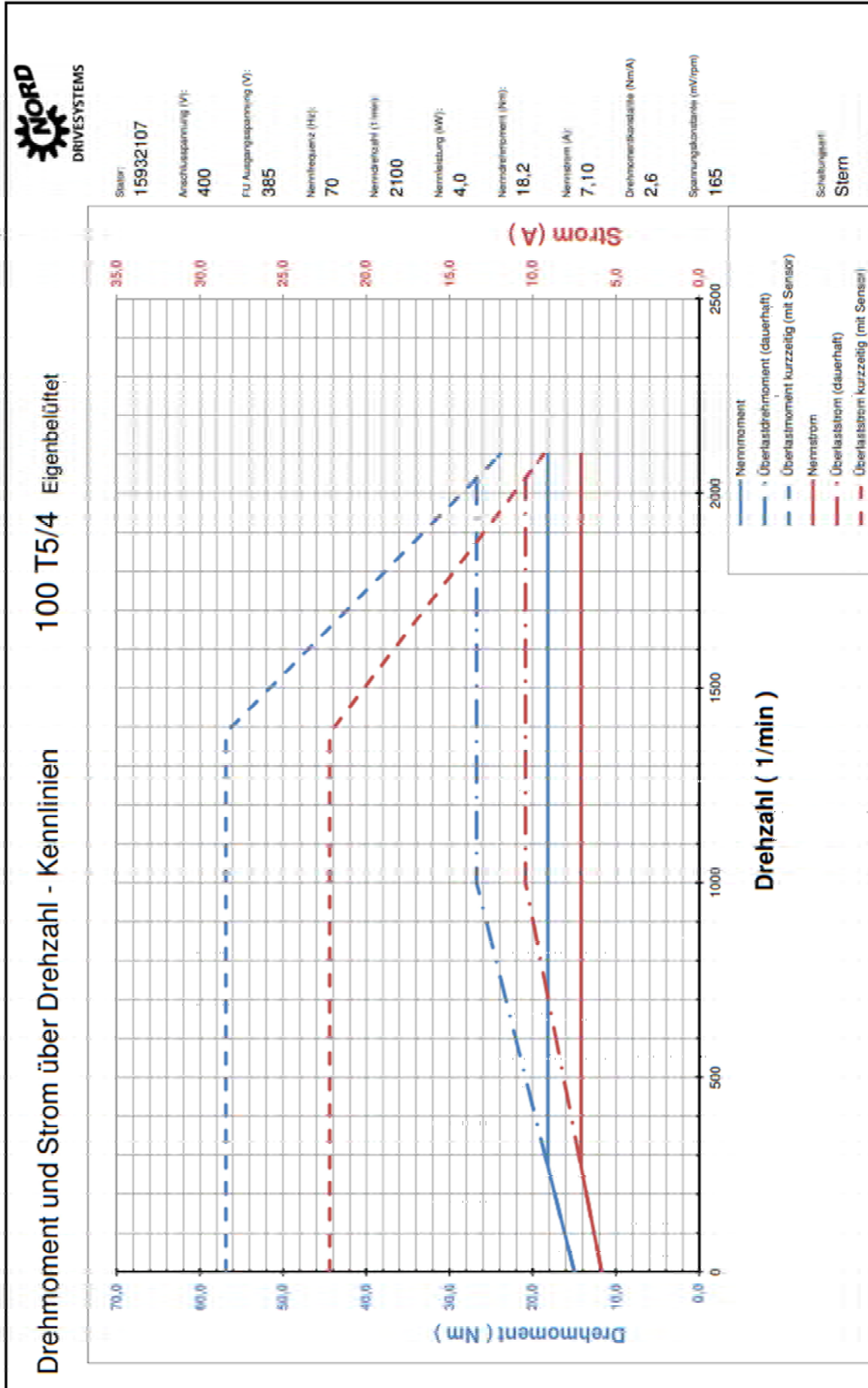
Motor

Description	Material
100T5/4 TF	
Product name	Motor
Motor Type	Synchronal motor
Motor speed	2.100 1/min
Power (kW)	4,000
Voltage (V)	400-460
Frequency (Hz)	70
Class of efficiency	IE4
Mode of operation	S1
Insulation Class	F
Motorposition	Mount acc. NORD sp. 754 IEC B5
Thermal motor protection	PTC resistor, 3x155°C
Type of motor connection	Star; High Voltage
Type of enclosure	IP66
Position of terminal box	3/I
Nameplate/Terminalbox	GNP+MNP+TB Std (VA)
CE Logo	Yes
CCC Logo	No
Colour	RAL 5015 Sky blue
Paint type	Standard paint
Painting instruction Old	Paint coat 3.2 standard
Weight	approx. 26 KG /PC

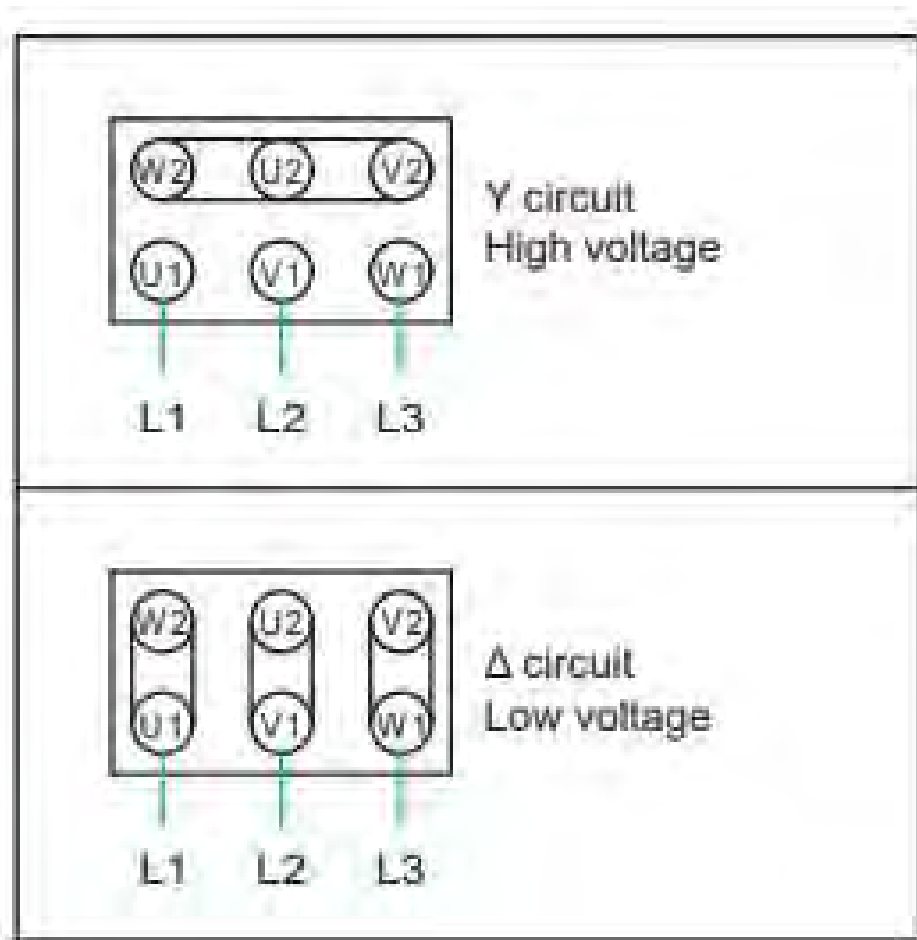
Motor Data Sheet

3 phase motor		Motor type: 100T5/4 TF	
Electrical data:		Order data:	
Frequency (f):	70 Hz	Order No.:	101572160-100
Output (P):	4,00 kW	Customer reference No.:	
Speed (n):	2100 1/min	Serial No.:	
Connection of stator:	D/Y	Motor No.:	
Voltage (V):	400-460 V	Stator No.:	15932107
Current (I):	A	General data:	
Voltage range (U _{vs}):	V	Direction of rotation:	CW/CCW
Wide range current (I _{ws}):	A	Design:	754 Motoranb. IEC B5 Ø250
Starting current/Current (I _s /I):		Duty:	S1
Rated motor torque (M _n):	18,19 Nm	Type bearing:	
Starting motor torque (M _s):	Nm	Housing material:	Aluminium
Minimum motor torque (M _s):	Nm	Insulation class:	F
Breakdown motor torque (M _k):	Nm	Type of protection:	IP 66
cos phi:	Last	Cable entry:	3 I
Eta(%):	100%	Moment of inertia:	kgm ²
Eta(%):	75%	Maximum altitude of site:	1.000 m
Eta(%):	50%	Ambient temperature:	-20°C to +40°C
Service Faktor:		Fan Type:	Standard IC 411
Code letter:			
Tested data:		Classification authorities:	
Connection of stator:	D/Y		
Voltage (V):	400-460 V		
No load current (I ₀):	A		
No load output (P ₀):	kW		
Noise level (L _{eqA}):	dB(A)		
Resistance stator winding at 20°C (R):	Ohm		
Temperature rise (T):	K		
(at the stator resistance method)			
Insulation resistance (R _{iso}):	100 Mega Ohm		
Winding test:	V/4 sek.		
Class of vibration:	A		
Motor options:			
TF: Thermistor			

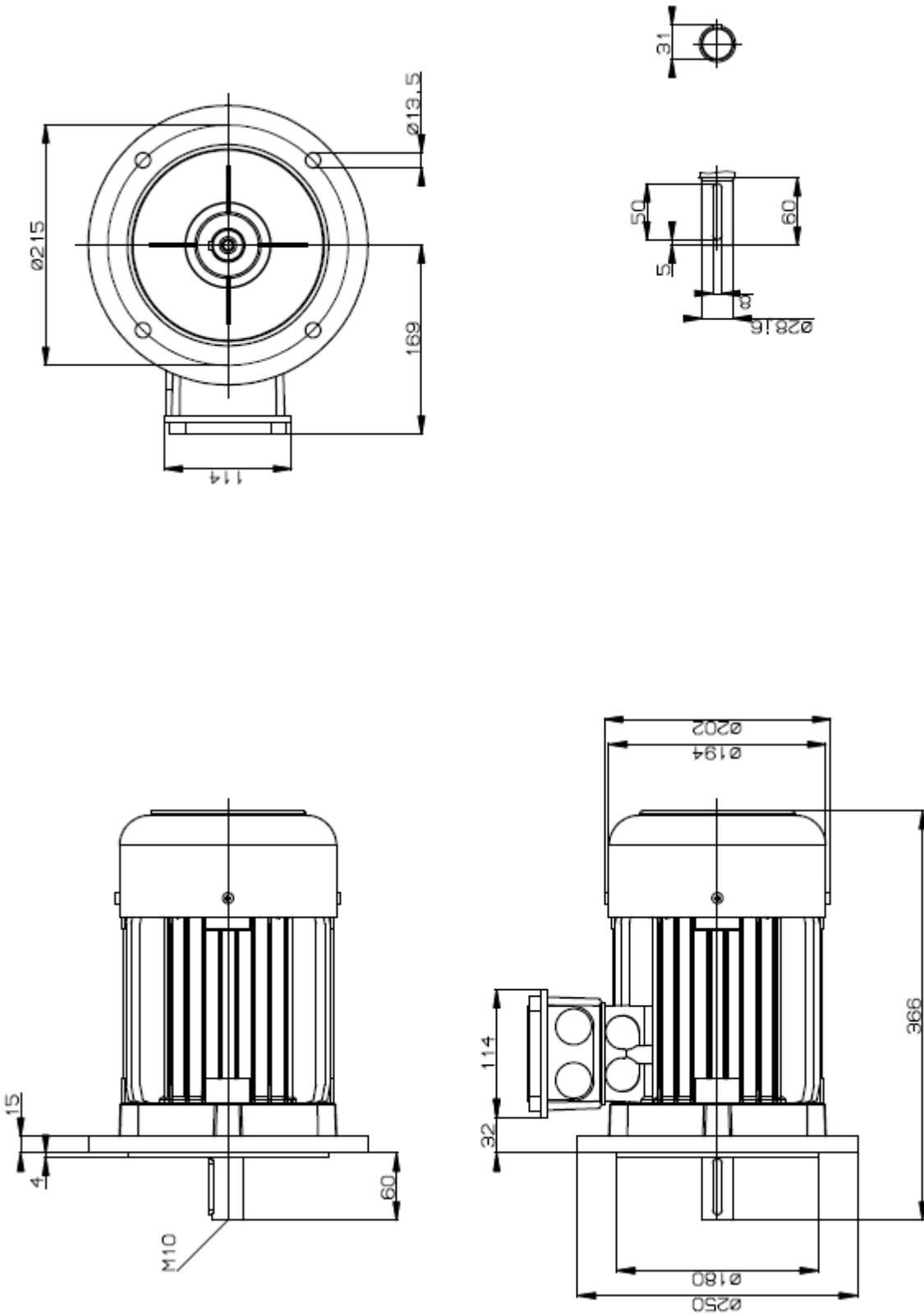
Motor Performance curve



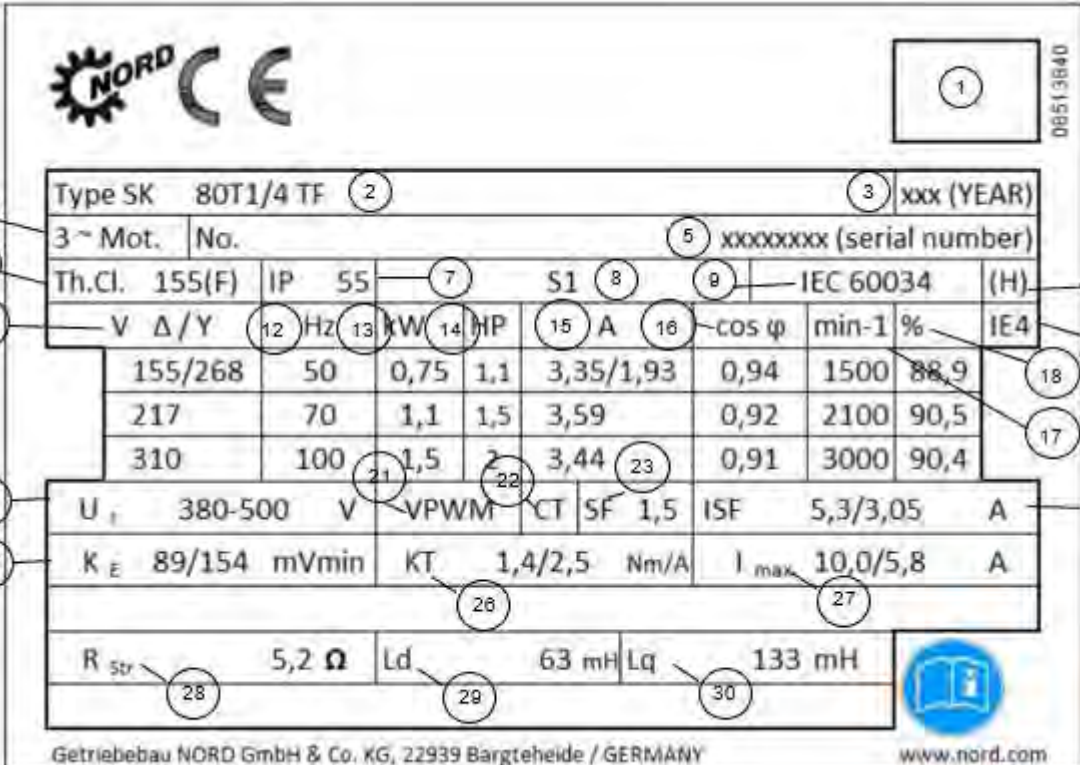
Motor Connection Diagrams



Drawing



Explanation of the rating plate



Type SK 80T1/4 TF (2)		(3) xxx (YEAR)	
3~ Mot. No.		(5) xxxxxxxx (serial number)	
Th.Cl. 155(F)	IP 55 (7)	S1 (8)	IEC 60034 (H) (10)
V Δ/Y (11)	Hz (12)	kW (13)	HP (14)
155/268	50	0,75	1,1
217	70	1,1	1,5
310	100	1,5	2
		A (15)	cos φ (16)
		3,35/1,93	0,94
		3,59	0,92
		3,44 (23)	0,91
		min-1	% (18)
		1500	88,9 (19)
		2100	90,5 (17)
		3000	90,4
U _r 380-500 V (20)	VPWM (21)	CT (22)	SF 1,5 (23)
		ISF	5,3/3,05 A (24)
K _E 89/154 mVmin (25)	KT (26)	1,4/2,5 Nm/A	I _{max} 10,0/5,8 A (27)
R _{str} (28)	5,2 Ω	Ld (29)	63 mH
		Lq (30)	133 mH

Getriebebau NORD GmbH & Co. KG, 22939 Bargteheide / GERMANY www.nord.com

- | | |
|------------------------|--|
| 1 Matrix – Barcode | 16 Power factor |
| 2 NORD – Motor Type | 17 Nominal speed |
| 3 Year of manufacture | 18 Efficiency in % |
| 4 Number of phases | 19 Efficiency class |
| 5 Serial number | 20 Rated Voltage |
| 6 Heat class | 21 Voltage source pulse width modulation |
| 7 Protection class | 22 Constant torque |
| 8 Operating mode | 23 Service factor |
| 9 Standard | 24 Current at Service factor |
| 10 Half key balancing | 25 Voltage constant |
| 11 Motor voltage | 26 Torque constant |
| 12 Frequency | 27 Maximum current |
| 13 Nominal power in kW | 28 Resistance stator winding |
| 14 Nominal power in HP | 29 d axis inductance |
| 15 Nominal current | 30 q axis inductance |

Certificate

CERTIFICATE OF COMPLIANCE

Certificate Number E469872
Report Reference E469872-20150428
Date 2020-November-09

Issued to: NORD MOTORIDUTTORI SRL
VIA NEWTON 22
S GIOVANNI PERSICETOBO 40017 IT

This is to certify that representative samples of SERVO AND STEPPER MOTORS
See Addendum Page for Product Designation(s).

Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.

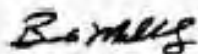
Standard(s) for Safety: UL 1004-1, Rotating Electrical Machines – General Requirements
UL 1004-6, Servo and Stepper Motors
CSA C22.2 No. 100-14, Motors and Generators

Additional Information: See the UL Online Certifications Directory at <https://iq.ulprospector.com> for additional information

This Certificate of Compliance does not provide authorization to apply the UL Mark. Only the UL Follow-Up Services Procedure provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



Bruce Mahrenholz, Director North American Certification Program

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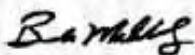
Certificate

CERTIFICATE OF COMPLIANCE

Certificate Number E469872
Report Reference E469872-20150428
Date 2020-November-09

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

SERVO AND STEPPER MOTORS, Model(s):
80T1/4, 80T1/4 , 90T1/4, 90T1/4 , 90T3/4, 90T3/4 , 100T2/4, 100T2/4, 100T5/4, 100T5/4 , 80T1/4
HM, 90T3/4 HM, 100T5/4 HM, 80T1/4 HMT, 90T3/4 HMT, 100T5/4 HMT, 71N1/8, 71N2/8, 71N3/8



Bruce Mahrenholz, Director North American Certification Program

UL LLC

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SERVICE

There are 3 North Service Centers in Central America. The right contact person can be found on our website www.nord.com you will also find your contact person for North and South America there.

APPENDIX INFORMATION

SK01F-63S/6 CUS



standard gear units



Gearmotors

Description	Material
Product name	Helical geared motor
Motor Type	CUS
Motor speed	1.050 1/min
Ratio	111,60
Output speed	9,400 1/min
Service factor	1,00
Output Torque M2 (Nm)	91,30
Power (kW)	0,090
Voltage (V)	265/460
Frequency (Hz)	60
Mode of operation	S1
Type of enclosure	IP66
Insulation Class	F
Nominal current 1 (AMP)	0,80
Nominal current 2 (AMP)	0,46
Cosinus 1	0,62
Environmental temp. motor	40°C
Mounting pos. of the gearbox	M4
Tilted mounting position	M6-45-M1
second tilted mounting pos.	M4-60-M1
Type of housing	Flange B5
Shaft dimension	17X30
Part no. special output shaft	000000000050134940
Flange diameter (mm)	120
Breather	Spring-loaded breather
Type of motor connection	Star; High Voltage
Position of terminal box	2/I
Lubricant type	ISO VG 220 mineral oil
class oil	CLP 220
Colour	RAL 5015 Sky blue
Paint type	Standard paint
Painting instruction Old	Paint coat 3.2 standard
Extra work Old	Sealing
Nameplate/Terminalbox	GNP+MNP+TB Std (VA)
CE Logo	Yes
CCC Logo	No
Weight	approx. 13 KG /PC

Motor Data Sheet

3 phase motor			Motor type: 63S/6 CUS		
Electrical data:			Order data:		
Frequency (f):	60	Hz	Order No.:	101588725-100	
Output (P):	0,09	kW	Customer reference No.:		
Speed (n):	1050	1/min	Serial No.:		
Connection of stator:	D/Y		Motor No.:		
Voltage (V):	265/460	V	Stator No.:	11042670	
Current (I):	0,80/0,46	A	General data:		
Voltage range (U _{Wb}):	V		Direction of rotation:	CW/CCW	
Wide range current (I _{Wb}):	A		Design:	Motoranb. WN Pos 958	
Starting current/Current (I _s /I):	1,80		Duty:	S1	
Rated motor torque (M _N):	0,82	Nm	Type bearing:		
Starting motor torque (M _s):	2 (2,44)*	Nm	Housing material:	Aluminium	
Minimum motor torque (M _s):	1,90 (2,32)*	Nm	Insulation class:	F	
Breakdown motor torque (M _k):	2 (2,44)*	Nm	Type of protection:	IP 66	
cos phi:	0,62	Last	Cable entry:	2 I	
Eta(%):	39,90	100%	Moment of inertia:	0,00028	kgm ²
Eta(%):	75%		Maximum altitude of site:	1.000	m
Eta(%):	50%		Ambient temperature:	-20°C	to +40°C
Service Faktor:	1,15		Fan Type:	Standard IC 411	
Code letter:	F				
Tested data:					
Connection of stator:	D/Y		Classification authorities:		
Voltage (V):	265/460	V	 		
No load current (I ₀):	0,64/0,37	A	NEMA (ELECTRICAL)		
No load output (P ₀):	0,094	kW			
Noise level (L _{eq}):	dB(A)				
Resistance stator winding at 20°C (R): 89 U1-U2	Ohm				
Temperature rise (T):	K				
(at the stator resistance method)					
Insulation resistance (R _{iso}):	100	Mega Ohm			
Winding test:	2352	V/4 sek.			
Class of vibration:	A				

Motor Performance curve



Stator: 11042670

Mn_{sc} 0,8 Nm

I_n 0,46 A
 I_0 0,45 A

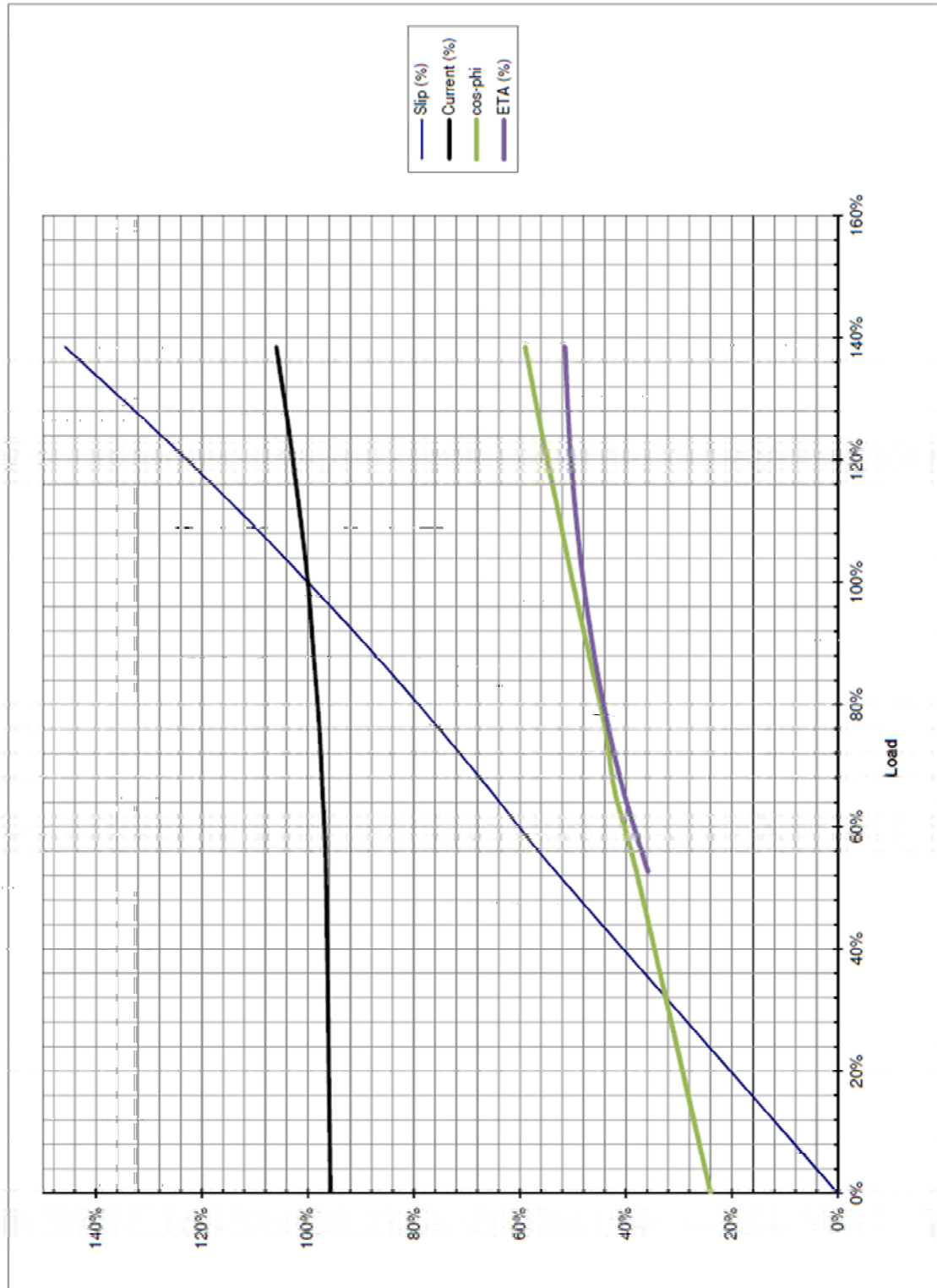
n 1050 1/min
 f 60 Hz

Voltage: 460 V

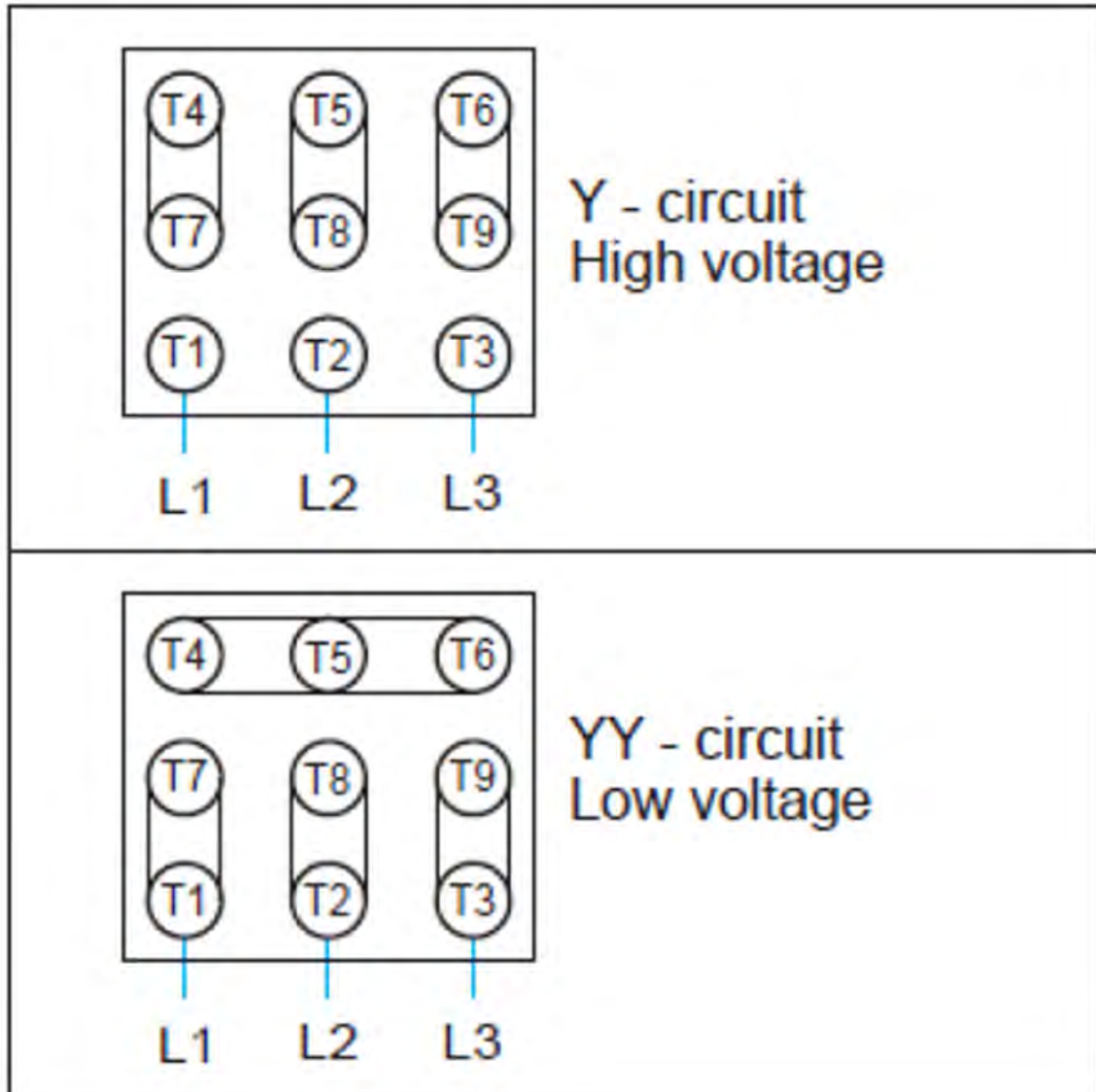
Power: 0,09 kW

Duty: S1

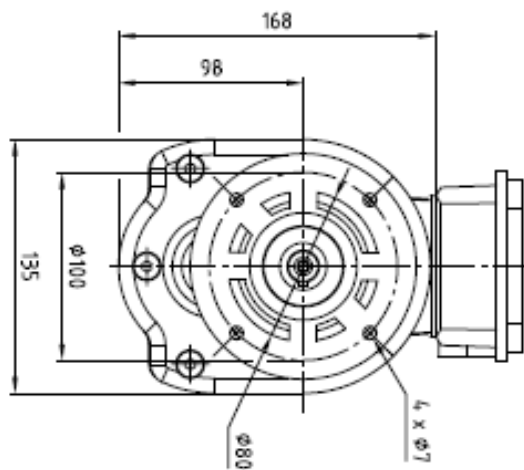
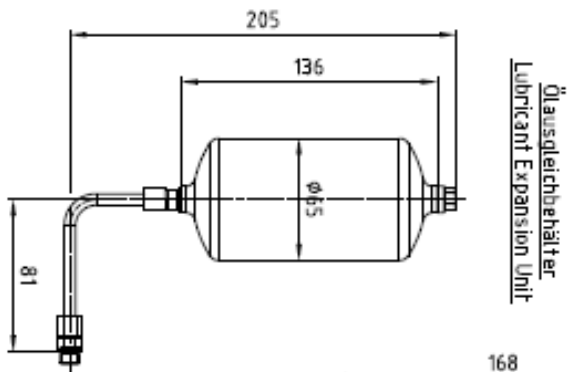
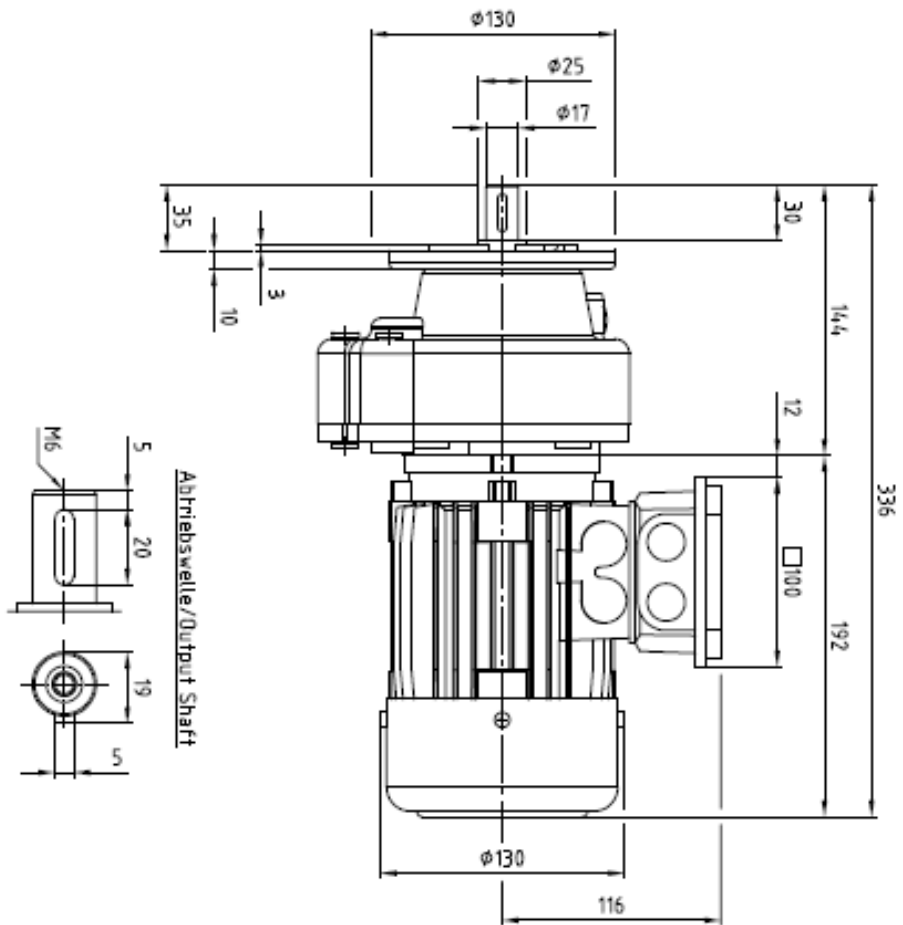
Load curves 63S/6 CUS



Motor Connection Diagrams



Drawing



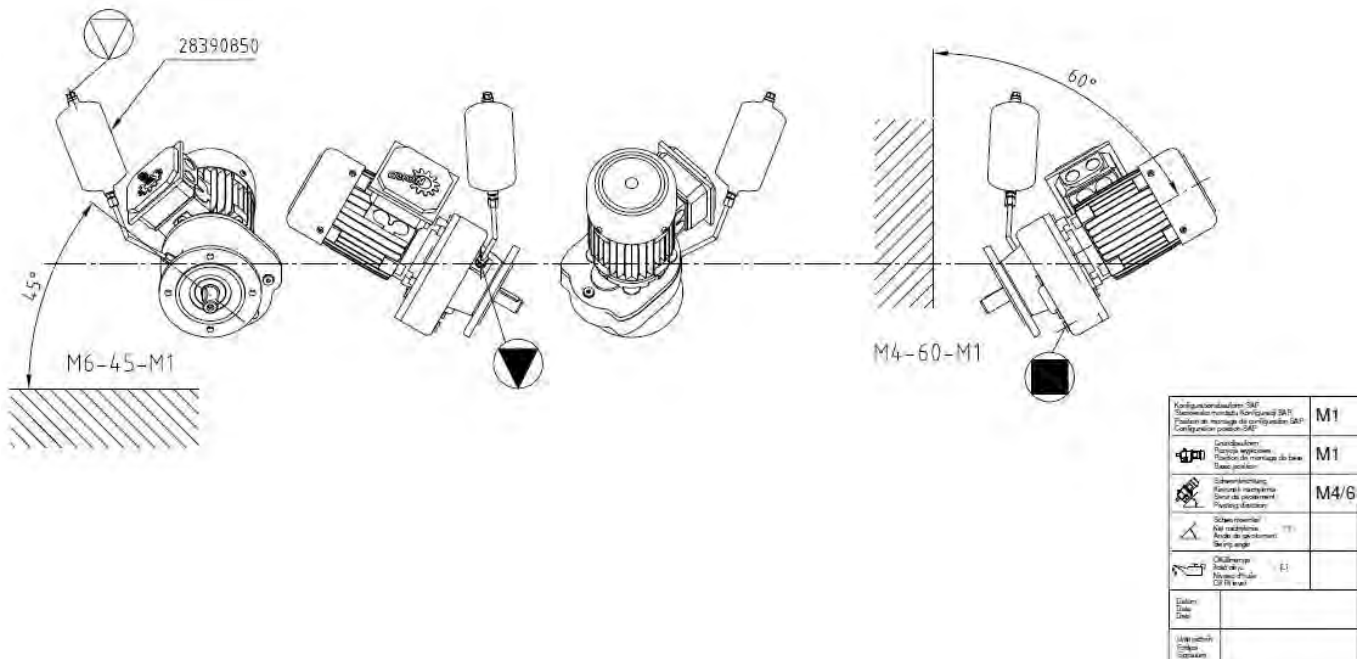
Lubricant table

This table shows comparable lubricants from various manufacturers. The manufacturer can be changed within a particular viscosity or lubricant type. Getriebebau NORD must be contacted in case of change of viscosity or lubricant type, as otherwise no warranty for the functionality of our gearboxes can be accepted.




Lubricant type	Details on type plate	DIN (ISO) / Ambient temperature					
Mineral oil	CLP 680	ISO VG 680 0...40 °C	Alpha EP 680 Alpha SP 680 Optigear BM 680 Tribol 1100 / 680	Renolin CLP 680 Renolin CLP 680 Plus	Klüberoil GEM 1-680 N	Mobilgear 600 XP 680	Omala S2 G 680
	CLP 220	ISO VG 220 -10...40 °C	Alpha EP 220 Alpha SP 220 Optigear BM 220 Tribol 1100 / 220	Renolin CLP 220 Renolin CLP 220 Plus Renolin Gear 220 VCI	Klüberoil GEM 1-220 N	Mobilgear 600 XP 220	Omala S2 G 220

Lubrication quantity in L: tbd

Symbols for oil screw plugs in the mounting positions



Attention: The OA has a 45 ° bend, insert as manufacturing note

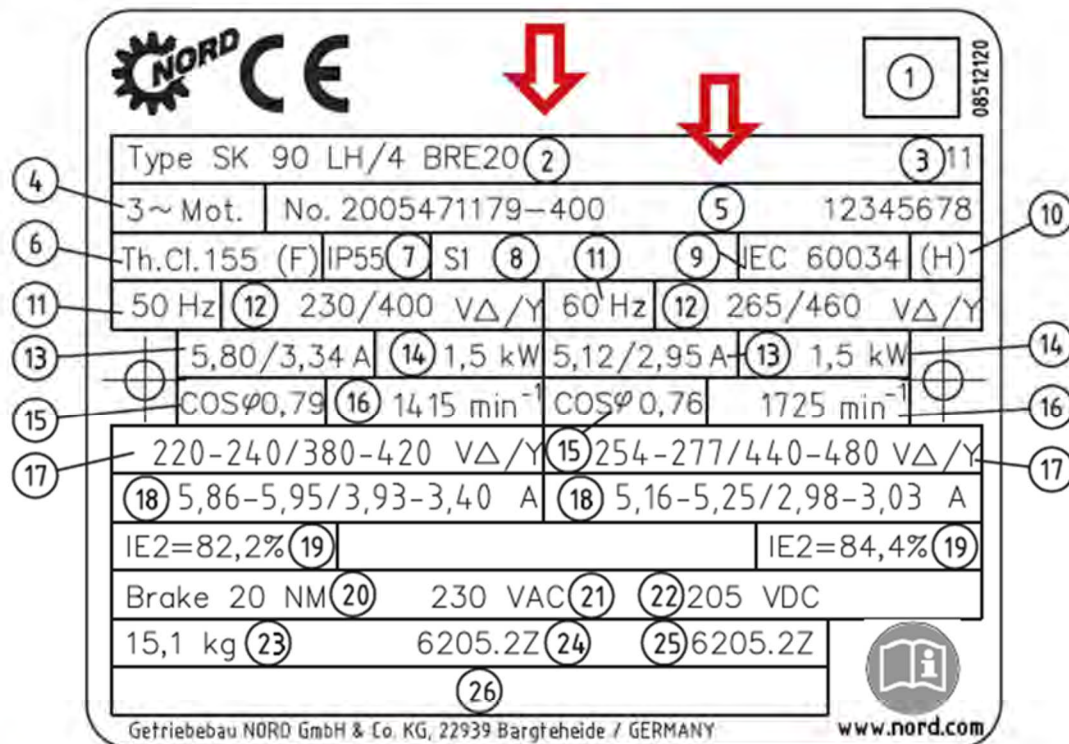
-  Entlüftung / Vent
-  Ölstand / Oil Level
-  Ölablass / Oil Drain

Explanation of the rating plate

Erläuterung des Typenschildes

Explanation of the rating plate

Explication de la plaque signalétique



DE

- 1 Matrix – Barcode
- 2 NORD - Motortyp
- 3 Herstellungsjahr
- 4 Phasenzahl
- 5 Fabrikationsnummer
- 6 Wärmeklasse
- 7 Schutzart
- 8 Betriebsart
- 9 Norm
- 10 Halbkeilwuchtung
- 11 Frequenz
- 12 Motorspannung
- 13 Nennstrom
- 14 Nennleistung
- 15 Leistungsfaktor
- 16 Nenn Drehzahl
- 17 Motorspannung - Weitbereich
- 18 Nennstrom - Weitbereich
- 19 Wirkungsgrad
- 20 Bremsmoment
- 21 Anschlußspannung Bremse
- 22 Bremsenspannung
- 23 Gewicht
- 24 Lagerung A-Seite
- 25 Lagerung B-Seite
- 26 Kundenzeile

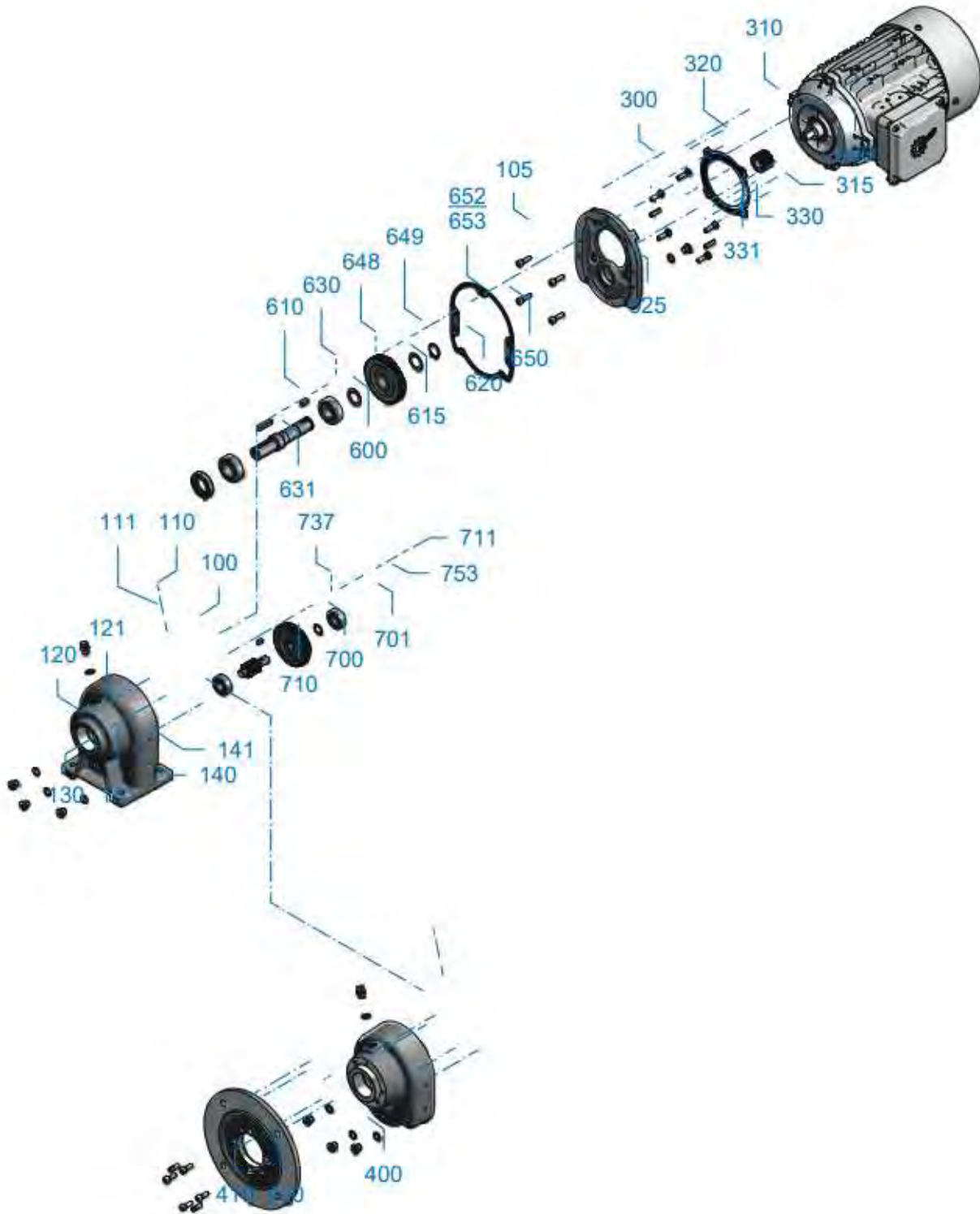
EN

- 1 Matrix – Barcode
- 2 NORD - Motor type
- 3 Year of manufacture
- 4 Number of phases
- 5 Serial number
- 6 Heat class
- 7 Protection class
- 8 Operating mode
- 9 Standard
- 10 Half key balancing
- 11 Frequency
- 12 Motor voltage
- 13 Nominal current
- 14 Nominal power
- 15 Power factor
- 16 Nominal speed
- 17 Motor voltage - wide range
- 18 Nominal current - wide range
- 19 Efficiency
- 20 Braking torque
- 21 Brake connection voltage
- 22 Braking voltage
- 23 Weight
- 24 A side bearing
- 25 B side bearing
- 26 Customer line

FR

- 1 Code matriciel, à barres
- 2 Type de moteur NORD
- 3 Année de fabrication
- 4 Nombre de phases
- 5 Numéro de série
- 6 Classe thermique
- 7 Type de protection
- 8 Type de fonctionnement
- 9 Norme
- 10 Équilibrage dynamique avec une demi-clavette
- 11 Fréquence
- 12 Tension du moteur
- 13 Intensité nominale
- 14 Puissance nominale
- 15 Facteur de puissance
- 16 Vitesse nominale
- 17 Tension du moteur – plage étendue
- 18 Intensité nominale - plage étendue
- 19 Rendement
- 20 Couple de freinage
- 21 Tension de raccordement du frein
- 22 Tension de freinage
- 23 Poids
- 24 Palier côté A
- 25 Palier côté B
- 26 Ligne réservée au client

Part list



Part list

DE	EN	FR
100	Housing	100 Carter
105	Seal	105 Joints d'étanchéité
110	Screw	110 Vis
111	Seal	111 Joints d'étanchéité
120	Screw	120 Vis
121	Seal	121 Joints d'étanchéité
130	Screw	130 Vis
131	Seal	131 Joints d'étanchéité
140	Screw	140 Vis
141	Seal	141 Joints d'étanchéité
300	Gear unit cover	300 Couvercle du réducteur
310	Seal	310 Joints d'étanchéité
315	Pin	315 Goupille
320	Screw	320 Vis
325	Screw	325 Vis
330	Screw	330 Vis
331	Seal	331 Joints d'étanchéité
400	Flange	400 Bride
410	Screw	410 Vis
420	Pin	420 Goupille
600	Output shaft	600 Arbre de sortie
610	Roller bearing	610 Palier à roulement
615	Roller bearing	615 Palier à roulement
620	Output gear	620 Roue de sortie
630	Parallel key	630 Clavette
631	Shaft sealing ring	631 Bague d'étanchéité de l'arbre
648	Parallel key	648 Clavette
649	Shim	649 Rondelle d'ajustage
650	Circlip	650 Circlip
652	Shim	652 Rondelle d'ajustage
653	Shim	653 Rondelle d'ajustage
700	Pinion shaft	700 Arbre de pignon
701	Drive gear	701 Roue d'entrée
710	Roller bearing	710 Palier à roulement
711	Roller bearing	711 Palier à roulement
737	Parallel key	737 Clavette
753	Shim	753 Rondelle d'ajustage
900	Drive pinion	900 Pignon d'entrée

Certificate

CERTIFICATE OF COMPLIANCE

Certificate Number 20170217-E191510
Report Reference E191510-19981208
Issue Date 2017-FEBRUARY-16

Issued to: NORD MOTORIDUTTORI SRL
VIA NEWTON 22
40017 S GIOVANNI PERSICETO BO ITALY

This is to certify that representative samples of MOTORS
SEE ADDENDUM PAGE.

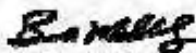
Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.

Standard(s) for Safety: UL 1004-1, CSA C22.2 No. 100-14 - Rotating Electrical Machines – General Requirements

Additional Information: See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's Certification and Follow-Up Service.

Look for the UL Certification Mark on the product.



Bruce Mahrenholz, Director North American Certification Program
UL LLC

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Certificate

CERTIFICATE OF COMPLIANCE

Certificate Number 20170217-E191510
Report Reference E191510-19981208
Issue Date 2017-FEBRUARY-16

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Model CUS series three phase motors. 2 or 3 digit prefix numbers indicating frame size followed by 1 or 2 letter indicating stator size followed by "r" plus numbers indicating speed(s). Letters and numbers follow model designation to indicate options and nominal power. Frames 63 to 250.

Model HM & HMT series three phase motors. 2 or 3 digit prefix numbers indicating frame size followed by 1 or 2 letter indicating stator size followed by "r" plus numbers indicating speed(s). Letters and numbers follow model designation to indicate options and nominal power. Frames 80 to 100.



Bruce Mahrenholz, Director North American Certification Program
UL LLC

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SERVICE

There are 3 North Service Centers in Central America. The right contact person can be found on our website www.nord.com you will also find your contact person for North and South America there.

Bauer-Artikel-Nr.: 188Z3209

Huber-ID.: 51311428

Position 1 Ro8 Ro8T 1.5HP

1 Stück BF40-74W-C/NEMA145TC/C2-MB
 Artikel-Nr.: 188Z3209

shaft-mounted gear

Type	: BF40-74W-C/NEMA145TC/C2-MB		
Design power P1	: 1,1 kW		
Design speed of the high-speed shaft n1	: 1760 rpm		
Design speed of the low-speed shaft n2	: 21,0 rpm		
Design torque at the high-speed shaft M1 at sf = 1,7	: 5,9 Nm		
Design torque at the low-speed shaft M2 at sf = 1,7	: 495 Nm		
max permissible input speed n1 with reduced torque	: 3600 rpm		
Mounting	: H2/V1	Dimensional drawing	: B.40-B.40Z-...-C-NEMA
Corrosion protection	: Coro 2	Catalogue	: -
Painting	: RAL 5015	net weight per unit	: approximately 69 kg

Add./Special design:

Total thickness of coating 100 µm
Mounting H2 inclined 35° to mounting V1.
3rd party motor acc. ZN.BAU2710186.
Manufacturer Baldor
1.5HP; 230/460V; 60Hz
4.4/2.2A; 1760RPM;
Class I; Division I
Premium Eff. 86.5%
Thermostats
DOL SF1.15
Inverterduty SF1.0
CT 6-60Hz, CHP 60-90Hz
Drip Cover, Sealing B-Side
Terminal box position III/A

Gear design:

Type	: BF40 2 -staged shaft-mounted gear
Design code 74W	: C-Flange with tapped holes on side front
	: hollow shaft with keyway
Total gear reduction i	: 83,91
Oil-type/-volume	: CLP 220 / 4,9 l
Add./Special design:	With double shaft seal on the output shaft.
	With threaded holes on gear side H.
	Special output shaft acc. ZN.BF40-36-A3-K4. (d): 45 mm, Ident.-Nr.: 30366720

BAU2710186



BALDOR • RELIANCE

Product Information Packet ABB Automation Products GmbH

1.5HP, 1760RPM, 3PH, 60HZ, 145TC, 3526M, XPFC

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BALDOR • RELIANCE Product Information Packet: BAU2710186 - 1.5HP, 1760RPM, 3PH, 60HZ, 145TC, 3526M, XPFC

Part Detail							
Revision:	B	Status:	PRD/A	Change #:		Proprietary:	Yes
Type:	AC	Elec. Spec:	35WGM493	CD Diagram:	CD0005	Mfg Plant:	
Mech. Spec:	35E3652	Layout:	35LYE3652	Poles:	04	Created Date:	08-25-2016
Base:	N	Eff. Date:	04-03-2017	Leads:	9#18		

Specs			
Enclosure:	XPFC	Inverter Code:	Inverter Duty
Frame:	145TC	KVA Code:	L
Frame Material:	Steel	Lifting Lugs:	No Lifting Lugs
Output @ Frequency:	1.500 HP @ 60 HZ	Locked Bearing Indicator:	Locked Bearing
Synchronous Speed @ Frequency:	1800 RPM @ 60 HZ	Motor Finish:	PRIMER
Voltage @ Frequency:	230.0 V @ 60 HZ	Motor Lead Quantity/Wire Size:	9 @ 18 AWG
	460.0 V @ 60 HZ	Motor Lead Exit:	Ko Box
XP Class and Group:	CLI GP C, D	Motor Lead Termination:	Flying Leads
XP Division:	Division I	Motor Type:	3526M
Agency Approvals:	UR	Mounting Arrangement:	F1
	CSA	Power Factor:	73
	CSA EEV	Product Family:	General Purpose
Auxiliary Box:	No Auxiliary Box	Pulley End Bearing Type:	Ball
Auxiliary Box Lead Termination:	None	Pulley Face Code:	C-Face
Base Indicator:	No Mounting	Pulley Shaft Indicator:	Standard
Bearing Grease Type:	Polyrex EM (-20F +300F)	Rodent Screen:	None
Blower:	None	RoHS Status:	ROHS COMPLIANT
Constant Torque Speed Range:	6	Shaft Extension Location:	Pulley End

Product Information Packet: BAU2710186 - 1.5HP,1760RPM,3PH,60HZ,145TC,3526M,XPFC

Current @ Voltage:	4.400 A @ 230.0 V	Shaft Ground Indicator:	No Shaft Grounding
	2.200 A @ 460.0 V	Shaft Rotation:	Reversible
Design Code:	B	Shaft Slinger Indicator:	Shaft Slinger
Drip Cover:	Drip Cover	Speed Code:	Single Speed
Duty Rating:	CONT	Motor Standards:	NEMA
Electrically Isolated Bearing:	Not Electrically Isolated	Starting Method:	Direct on line
Feedback Device:	NO FEEDBACK	Thermal Device - Bearing:	None
Front Face Code:	Drip Cover Mounting	Thermal Device - Winding:	Normally Closed Thermostat
Front Shaft Indicator:	None	Vibration Sensor Indicator:	No Vibration Sensor
Heater Indicator:	No Heater	Winding Thermal 1:	None
Insulation Class:	F	Winding Thermal 2:	None
		XP Temp Code:	T3C

BALDOR • RELIANCE Product Information Packet: BAU2710186 - 1.5HP,1760RPM,3PH,60HZ,145TC,3526M,XPFC

Nameplate NP1401XPSLEV	
NO.	
S/N	
SPEC.	35E3652M493G1
CAT.NO.	
HP	1.5
VOLTS	230/460
AMPS	4.4/2.2
RPM	1760
HZ	60
SER.F.	1.00
FRAME	145TC
	1.15SF ON SINEWAVE
	55C RISE
	BAU2710186
	CC D10A
	TEMP CODE T3C
	INV. TYPE PWM
	C HP FR 60
	CT HZ FROM 6
	VT HZ FROM 6
	CHP TO 90
	CT HZ TO 60
	VT HZ TO 60
	MAG CUR 2.8/1.4
	MX RPM 2700
	NOM.EFF. 86.5
	PH 3
	DES B
	CL F
	SL HZ 1.3
	WK2 0.154
	RATING 40C AMB-CONT

Parts List		
Part Number	Description	Quantity
SA326326	SA 35E3652M493G1	1.000 EA
RA314220	RA 35E3652M493G1	1.000 EA
35CB1005A01	CONDUIT BOX,MACH - GROUP "C" MTRS	1.000 EA
11XW1032G06	10-32 X .38, TAPTITE II, HEX WSHR SLTD U	1.000 EA
35EP1715A63	FREP XPFC 203 BRG GP-C WIGRSR, REL, DRAI	1.000 EA
HW4500A03	GREASE FITTING, .125 NPT 1610(ALEMITE) 8	1.000 EA
HW4500A20	1/8NPT SL PIPE PLUG	1.000 EA
HW4601B23	INPRO SEAL, 203 BRG, MINI66	1.000 EA
HW5100A03	WAVY WASHER (W1543-017)	1.000 EA
HW4506A02	BREATHER/DRAIN-EXP PROOF- 125-27 NPTF AI	1.000 EA
HW3022E05	.125 DIA X .500 ROLLED SPRING PIN	1.000 EA
HA2009A89	SPACER FOR XP MTRS - 205 BRG.	1.000 EA
35EP1704A40	PUEP 205 BRG XP,GP C,ALUM SLINGER,DRAIN	1.000 EA
HW4506A02	BREATHER/DRAIN-EXP PROOF- 125-27 NPTF AI	1.000 EA
HW3022E05	.125 DIA X .500 ROLLED SPRING PIN	1.000 EA
51XN1032A20	10-32 X 1 1/4 HX WS SL SR	2.000 EA
60XN1032A07	10-32 X 1/2 TRUSS HEAD, TORX SERRATED ZN	2.000 EA
HW4001A01	1/4 HX SOC PIPE PLG (F/S) ALLOY STEEL W/	2.000 EA
XY3118A12	5/16-18 HEX NUT DIRECTIONAL SERRATION	4.000 EA
35FH5000A52	FAN COVER/DRIP COVER ASSY, W/ PRIMER	1.000 EA
51XW1032A06	10-32 X .38, TAPTITE II, HEX WSHR SLTD S	3.000 EA
RM1020A41	O-RING, -150 BUNA-N, .103 CS X 2.862 ID	1.000 EA
35CB1501A01	CONDUIT BOX LID, MACH. - GROUP "C" MTRS	1.000 EA
HA2071A02	SLINGER ALUM (AUTO)	1.000 EA

Parts List (continued)		
Part Number	Description	Quantity
80XN1032A04	10-32 X 1/4 SET SCREW	1.000 EA
HW2501D13	KEY, 3/16 SQ X 1.375	1.000 EA
HA7000A01	KEY RETAINER 7/8" DIA SHAFT	1.000 EA
85XU0407S04	4X1/4 U DRIVE PIN STAINLESS	6.000 EA
LB1359F	ALUM XP CAUTION LABEL	1.000 EA
HW3001B01	BRASS CUP WASHER, FOR #8 SCREW	1.000 EA
MJ1000A02	GREASE, POLYREX EM EXXON (Use 4824-15A)	0.050 LB
35FN3002A05SP	EXFN, PLASTIC, 6.376 OD, .638 ID	1.000 EA
51XB1214A16	12-14X1.00 HXWSSLD SERTYB	1.000 EA
MG1500G03-5	LACQUER PRIMER, GRAY - 5 GAL	0.017 GA
HA3104A08	THRUBOLT-5/16-18X9.375 X X	4.000 EA
MN416A01	TAG-INSTAL-MAINT no wire (1100/bx) 11/14	1.000 EA
LB1119N	WARNING LABEL	1.000 EA
LC0145B01	CONNECTION LABEL	1.000 EA
NP1401XPSLEV	SS XP INV UL CSA-EEV CC CL-I GP-C&D	1.000 EA
36PA1001	PKG GRP, PRINT PK1017A06	1.000 EA
PK3082	STYROFOAM CRADLE	1.000 EA
PK5535A01	MODIFIED STD EURO PALLET 47-1/4 X 31-1/2	1.000 EA
LB1417	LABEL CARTON 6X4 PERFORATED BLANK ROLLS	1.000 EA

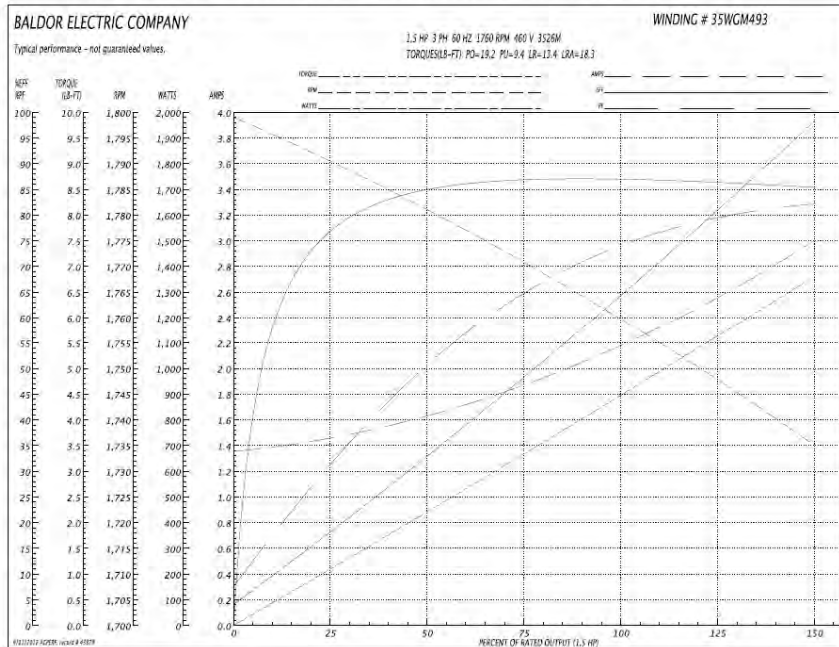
AC Induction Motor Performance Data
Record # 43879 - Typical performance - not guaranteed values

Winding: 35WGM493-R024		Type: 3526M		Enclosure: XPFC	
Nameplate Data				460 V, 60 Hz: Single Voltage Motor	
Rated Output (HP)	1.5			Full Load Torque	4.47 LB-FT
Volts	230/460			Start Configuration	direct on line
Full Load Amps	4.4/2.2			Breakdown Torque	19.2 LB-FT
R.P.M.	1760			Pull-up Torque	9.4 LB-FT
Hz	60	Phase	3	Locked-rotor Torque	13.4 LB-FT
NEMA Design Code	B	KVA Code	L	Starting Current	18.3 A
Service Factor (S.F.)	1			No-load Current	1.37 A
NEMA Nom. Eff.	86.5	Power Factor	73	Line-line Res. @ 25°C	10.1 Ω
Rating - Duty	40C AMB-CON I			I temp. Rise @ Rated Load	44°C
				Rotor inertia	0.154 LB-FT ²

Load Characteristics 460 V, 60 Hz, 1.5 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	31	51	65	73	79	83
Efficiency	76.3	84.5	86.9	87.2	86.5	85.4
Speed	1791	1781	1771	1760	1748	1735
Line amperes	1.44	1.61	1.86	2.19	2.58	2.98

Performance Graph at 460V, 60Hz, 1.5HP Typical performance - Not guaranteed values



APPENDIX A-I

See submittal package for Appendix A through Appendix I folders.