

CONTRACT DOCUMENTS

WPCF BATTERY B SECONDARY CLARIFIER FLOW CONTROL

City of Flint
1101 S. Saginaw St., Flint, MI 48502

June 2023



555 S. Saginaw St., Suite 201, Flint, MI 48502



COF107701F

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SECTION 00 11 13
ADVERTISEMENT FOR BIDS

WPCF Battery B Secondary Clarifier Flow Control

Sealed Bids will be received by City of Flint at the Department of Purchases and Supplies Room 203, 1101 S. Saginaw Street, Flint, Michigan, 48502, until 11:00 A.M. Local Time, 07-20-2023. After the bid closing time, Bids will be reviewed and publicly read aloud at the McKenzie Conference Room.

Bids will be received for the following Work:

Replacement of existing flow control valves for the four Battery B secondary clarifiers with flow meters and replacement of the RAS control and shutoff valves for each clarifier with flow meter with associated work in the flow control vault including HVAC/sump pump replacement, hatch replacement, electrical and other miscellaneous upgrades.

Contract Documents may be examined at the following locations:

1. City of Flint, Water Pollution Control Facility, Michigan, 48532
2. Wade Trim, Inc., 555 S. Saginaw St., Suite 201, Flint, MI 48502
3. Plans and spec are also available for viewing (not to be used for bidding purposes) at no cost online at: www.wadetrim.com/resources/bid-tab/

Each Proposal shall be accompanied by a bid bond, in the amount of at least **five (5)** percent of the amount bid, drawn payable to City of Flint as security for the proper execution of the Agreement.

A mandatory pre-bid conference will be held at 11:00 AM, Local Time, on 07-11-2023 at the Water Pollution Control Facility (G-4652 Beecher Rd., Flint MI 48532). It is a requirement for any prospective General Contractor bidding to attend this mandatory meeting. Representatives of the Owner and the Engineer will be present to discuss the project. Attendance is required for Bidders to be considered responsive.

City of Flint reserves the right to accept or reject any or all bids and to waive any informality in any bids should it consider same to be in its best interest.

Bids may not be withdrawn for the period of 60 days after date of receiving bids.

All inquiries shall be directed to Trevor Wagenmaker, PE - Engineer at Phone:1-810-620-0069 or email: twagenmaker@wadetrim.com.

SECTION 00 21 13 INSTRUCTIONS TO BIDDERS

PART 1 GENERAL

1.01 DEFINED TERMS

- A. Terms used in these Instructions to Bidders have the meanings assigned to them in the General Conditions.
- B. The term "Bidder" means one who submits a Bid directly to Owner as distinct from a subbidder who submits a Bid to a Bidder.
- C. The term "Successful Bidder" means the lowest, qualified, responsible Bidder to whom the Owner makes an award.
- D. The term "Owner" means City of Flint, Water Pollution Control Facility, Flint, Michigan, 48532, a Municipal Corporation and being a party of the first part of this Contract.
- E. The term "Engineer" means Wade Trim, Inc., 555 S. Saginaw St., Suite 201, Flint, MI 48502, or a duly authorized representative.

1.02 BIDDERS QUALIFICATIONS

- A. No Bid will be considered from any Bidder unless known to be skilled and regularly engaged in work of a character similar to that covered by the Contract Documents. In order to aid the Owner in determining the responsibility of any Bidder, the Bidder, within 48 hours after being requested in writing by the Owner to do so, shall furnish evidence, satisfactory to the Owner, of the Bidder's experience and familiarity with Work of the character specified, and Bidder's financial ability to properly prosecute the proposed Work to completion within the specified time. The evidence requested may include, but shall not be limited to, the following:
 - 1. Address and description of the Bidder's plant or permanent place of business.
 - 2. Bidder's performance records for all Work awarded to or started by Bidder within the past three years.
 - 3. An itemized list of the Bidder's equipment available for use on the proposed Contract.
 - 4. Bidder's financial statement, including statement of ownership of equipment necessary to be used in executing Work under Contract.
 - 5. Evidence that the Bidder is authorized to do business in the state in which the project is located, in case of a corporation organized under the laws of any other state; and,
 - 6. Such additional information as will satisfy the Owner that the Bidder is adequately prepared to fulfill the Contract.

1.03 EXAMINATION OF CONTRACT DOCUMENTS AND SITE

- A. It is the responsibility of each Bidder before submitting a Bid, to:
 - 1. Examine the Contract Documents thoroughly,
 - 2. Visit the site to familiarize himself with local conditions that may in any manner affect cost, progress or performance of the Work,
 - 3. Consider federal, state, and local Laws and Regulations that may affect cost, progress, performance, or furnishing of the Work; and
 - 4. Study and carefully correlate Bidder's knowledge and observations with the Contract Documents and such other related data; and
 - 5. Promptly notify the Engineer in writing of conflicts, errors, ambiguities or discrepancies which Bidder has discovered in or between Contract Documents and such related documents.

6. Purchase official Procurement Documents from the Engineer in order to be included on the project Plan Holder List and be considered eligible for bidding.
- B. Reference is made to the Supplementary Conditions for the identification of those reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work which have been relied upon by the Engineer in preparing the Contract Documents.
1. If such reports are not included as appendices to the Contract Documents, the Owner will make copies available to any Bidder requesting them. These reports are included for reference only and are not guaranteed as to accuracy or completeness, nor are they part of the Contract Documents.
 2. The Bidder may rely upon the general accuracy of the "technical data" contained in such reports but not upon other data, interpretations, opinions or information contained in such reports or otherwise relating to the subsurface conditions at the site, nor upon the completeness thereof for bidding or construction purposes.
 3. Before submitting their Bid each Bidder will, at Bidder's own expense, make such additional investigations and tests as the Bidder may deem necessary to determine Bidder's Bid for performance of the Work in accordance with the time, price and other terms and conditions of the Contract Documents.
- C. On request, the Owner will provide each Bidder access to the site to conduct such investigations and tests as each Bidder deems necessary for submission of their Bid. Bidder shall fill all holes and clean up and restore the site to its former conditions upon completion of such investigations and tests.
- D. The lands upon which the Work is to be performed, rights-of-way for access thereto and other lands designated for use by the Contractor in performing the Work are identified in Section 01 11 00 - Summary of Work, or on the Plans.
- E. The locations of utilities as shown on the Plans are taken from sources believed to be reliable. Neither the Owner nor the Engineer will be responsible for any omissions of, or variations from, the indicated location of existing utilities which may be encountered in the Work.
1. The submission of a Bid will constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Article 1.04, that without exception the Bid is based upon performing and furnishing the Work required by the Contract Documents and applying the specific means, methods, techniques, sequences or procedures of construction (if any) that may be shown, indicated or required by the Contract Documents, that Bidder has given the Engineer written notice of all conflicts, errors, ambiguities and discrepancies that Bidder has discovered in Contract Documents and the resolution by the Engineer is acceptable to Bidder, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performing and furnishing the Work, and that the time stated in the Proposal is sufficient to complete the project.

1.04 PRE-BID CONFERENCE

- A. An in-person, mandatory pre-bid conference will be held, and representatives of the Owner and the Engineer will be present to discuss the Project.
- B. Bidders are required to attend and participate in the conference to be considered responsive.
- C. Engineer will transmit to prospective Bidders a record of such Addenda as the Engineer considers necessary in response to questions arising at the meeting. Oral statements made during the meeting may not be relied upon and will not be binding or legally effective.

1.05 INTERPRETATIONS AND ADDENDA

- A. Should any prospective bidder find discrepancies in, or omissions from the Plans, Specifications or other parts of the Contract Documents, he may submit a written request to the

Engineer for an interpretation thereof. The person submitting the request will be held responsible for its prompt delivery at least seven (7) days prior to the date for opening of Bids. Questions received less than seven (7) days prior to the date for opening of bids will not be answered. Any interpretation of inquiry will be made by Addendum duly issued to all prospective bidders.

- B. Any change in or addition to the Contract Documents deemed necessary by the Owner shall be made in the form of an Addendum issued to all prospective bidders who have taken out Contract Documents and all such Addenda shall become a part of the Contract Documents as though same were incorporated into same originally. Oral explanations and information do not constitute official notification and are not binding.

1.06 BID SECURITY

- A. Bid Security shall be made payable to the Owner, in an amount of **five (5)** percent of the Bidder's maximum Bid price and in a form as indicated in the Advertisement. Bid Bonds, if indicated as acceptable in the Advertisement, shall be issued on the form included in the Contract Documents by a Surety meeting the requirements of paragraph 5.01 of the General Conditions.
- B. The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required Contract Security, whereupon it will be returned; if the successful Bidder fails to execute and deliver the Agreement and furnish the required Contract Security within 15 days of the Notice of Award, the Owner may annul the Notice of Award and the Bid Security of that Bidder will be forfeited.
- C. The Bid Security of any Bidder whom the Owner believes to have a reasonable chance of receiving the award may be retained by the Owner until the earliest of the seventh day after the "Effective Date of Agreement" (which term is defined in the General Conditions) or the expiration of the hold period on the Bids. Bid Security of other Bidders will be returned within 14 days of the Bid opening, unless indicated otherwise in the Advertisement.

1.07 CONTRACT TIME

- A. The number of days within which, or the date by which, the Work is to be Substantially Completed, if applicable, and also completed and ready for final payment (the Contract Time) are set forth in the Agreement.

1.08 SUBSTITUTE AND "OR-EQUAL" ITEMS

- A. The Contract, if awarded, will be on the basis of materials and equipment described in the Plans or specified in the Specifications without consideration of possible substitute or "or-equal" items.
- B. Whenever it is indicated in the Plans or specified in the Specifications that a substitute or an "or-equal" item of material or equipment may be furnished or used by the Contractor if acceptable to the Engineer, application for such acceptance will not be considered by the Engineer until after the Effective Date of Agreement.
- C. In addition, in no case shall the Engineer's denial of the Contractor's application give rise to any claim for additional cost, it being understood by the Contractor that acceptance of substitute or an "or equal" item of material is at the sole discretion of the Engineer.

1.09 RECEIPT AND FORM OF BID

- A. Bids shall be submitted at the time and place indicated in the Advertisement for Bids and shall be accompanied by the Bid Security and other required documents.
 - 1. Bids shall be submitted electronically only as specified herein.
 - 2. Bids shall be in an opaque sealed envelope, marked with the Project title and name and address of the Bidder and accompanied by the Bid Security and other required documents.

3. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face thereof.
- B. Any Bid received after the scheduled time and place indicated in the Advertisement for Bids shall be returned unopened.
- C. Owner invites bids on the Proposal and any other form(s) attached thereto.
- D. The complete set of Contract Documents must be used in preparing Bids; neither the Owner nor the Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Contract Documents.
- E. The Bid shall include such amounts as the Bidder deems proper for overhead, profit, taxes, General Conditions and such other incidentals as noted in the Contract Documents.
- F. The Bidder shall acknowledge receipt of all Addenda as provided for in the electronic bidding platform. Failure to acknowledge Addenda shall be cause for rejection of bid.
- G. The Legal Status of Bidder Form contained in the Contract Documents must be submitted with each Bid and must clearly state the legal position of a Bidder. In the case of a corporation, the home address, name and title of all officers must be given. In the case of a partnership, show names and home addresses of all partners. If an individual, so state. Any individual bid not signed by the individual must have attached, thereto, a power of attorney evidencing authority to sign.
- H. Other documents to be attached to the Proposal and made a condition thereof are identified in the Proposal.
- I. A tabulation of the amounts of the base bids and any alternates will be made available after the opening of Bids.

1.10 MODIFICATIONS AND WITHDRAWAL OF BIDS

- A. Bids 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 at any time prior to the opening of Bids.
- B. If, within 24 hours after Bids are opened, any Bidder files a duly signed written notice with the Owner and promptly thereafter demonstrates to the reasonable satisfaction of the Owner that there was a material and substantial mistake in the preparation of their Bid, that Bidder may withdraw their Bid and the Bid Security will be returned.
 1. Thereafter, at the sole option of the Owner, that Bidder will be disqualified from further Bidding on the Work to be provided under the Contract Documents.

1.11 AWARD OF CONTRACT

- A. Owner reserves the right to reject any and all Bids for any reason, to waive any and all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder, and the right to disregard all nonconforming, non-responsive, unbalanced, or conditional Bids.
- B. Discrepancies between words and figures will be resolved in favor of words. Discrepancies in the multiplication of units of work and unit prices, will be resolved in favor of unit price.
- C. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.
- D. In evaluating Bids, the Owner shall consider the qualifications of the Bidders, whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data if requested in the Bid forms. It is the Owner's intent to accept alternates (if any are accepted) in the order in which they are listed in the Bid Form but the Owner may accept them in any order or combination.

- E. Subject to the approval of the Owner, the Contract will be awarded to the lowest responsive and responsible Bidder. Responsibility of Bidder will be determined on basis of past performance and Work of similar character, equipment and labor available to do the Work and financial status.
- F. The Contract shall be considered to have been awarded after the approval of the Owner has been duly obtained and a formal Notice of Award duly served on the successful Bidder by the Owner.
- G. If the Contract is to be awarded, the Owner will give the successful Bidder a Notice of Award within 60 days after the day of the Bid opening, unless such other time is specified in the Advertisement for Bids.
- H. The Contract shall not be binding upon the Owner until the Agreement has been duly executed by the Bidder and the duly authorized officials of the Owner.

1.12 SIGNING OF AGREEMENT

- A. Within fifteen (15) days after the Owner gives a Notice of Award to the successful Bidder, the Contractor shall sign and deliver the specified number of counterparts of the Agreement to the Owner with all other Contract Documents attached.
- B. Within ten (10) days thereafter, the Owner will deliver two (2) fully signed counterparts to the Contractor. Engineer will identify, date or correct those portions of the Contract Documents not fully signed, dated or executed by the Owner and the Contractor and such identification, dating or correction shall be binding on all parties.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 00 42 43
PROPOSAL**

City of Flint - Water Pollution Control Facility, Flint, Michigan 48532

Project: WPCF Battery B Secondary Clarifier Flow Control

BIDDER INFORMATION

Bidder Name: _____

By (Printed Name): _____

Signature: _____

Address: _____

Phone No: _____

Email: _____

The Bidder proposes and agrees, if their Bid is accepted, to enter into an Agreement with the City of Flint in the form included in the Contract Documents to complete all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in the Agreement, and in accordance with the Contract Documents.

In submitting their Bid, Bidder represents, as more fully set forth in the Agreement, that:

1. Bidder has examined copies of all Contract Documents, (consisting of Plans dated Ready for Bidders date and Project Manual dated Ready for Bidders date) which he understands and accepts as sufficient for the purpose, including any and all Addenda officially issued, the receipt of which has been acknowledged.
 - A. Addendum _____ Acknowledged by: _____ Date: _____
 - B. Addendum _____ Acknowledged by: _____ Date: _____
 - C. Addendum _____ Acknowledged by: _____ Date: _____
2. Bidder has examined the surface and subsurface conditions where the Work is to be performed, the legal requirements and local conditions affecting cost, progress, furnishing or performance of the Work, and has made such independent investigations as Bidder deems necessary.
3. Their Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation 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 person, firm or a corporation to refrain from bidding; and Bidder has not sought by collusion to obtain for himself any advantage over any other Bidder or over the Owner.
4. The Bidder agrees to complete the Work, in accordance with the Contract Documents, for the following Contract Price:

Item	Description	Quantity	Unit	Unit Price	Amount
1	Battery B Secondary Clarifier Flow Control	1	LSUM	\$ _____	\$ _____
2	Allowance, MAK Controls				\$27,000.00
3	Owner-Controlled Contingency				\$150,000.00

Total Contract Price (Items 1 through 3) \$ _____

5. The Bidder by submitting a Bid, thereby certifies that Bidder or a qualified designated person in Bidder's employ has examined the Contract Documents provided by the Owner for bidding purposes. Further, they certify that Bidder or Bidder's qualified employee has reviewed the Bidder's proposed construction methods and finds them compatible with the conditions which Bidder anticipates from the information provided for Bidding.
6. The Bidder by submitting a Bid agrees to complete the Work under any job circumstances or field conditions present and/or ascertainable prior to bidding. In addition, Bidder agrees to complete the Work under whatever conditions Bidder may create by Bidder's own sequence of construction, construction methods, or other conditions he may create, at no additional cost to the Owner.
7. The Bidder by submitting a Bid, declares that Bidder has familiarized them self with the location of the proposed Work and the conditions under which it must be constructed. Also, Bidder has carefully examined the Plans, the Specifications, and the Contract Documents, which Bidder understands and accepts as sufficient for the purpose, and agrees that Bidder will Contract with the Owner to furnish all labor, material, tools, and equipment necessary to do all Work specified and prescribed for the completion of the Project.
8. The Bidder will provide a bid bond, in the amount of at least **five (5)** percent of the amount Bid, drawn payable to City of Flint as security for the proper execution of the Agreement.
9. The Bidder by submitting a Bid agrees that if awarded Contract, to sign the Agreement and submit satisfactory bonds and certificates of insurance coverage and other evidence of insurance required by the Contract Documents within 15 days after the date of Owner's Notice of Award.
10. The Bidder by submitting a Bid agrees that time is of the essence and, if awarded Contract, that the Work will be Completed on or before the dates/days as specified in the Agreement.
11. Liquidated damages, as specified in the General Conditions, Supplementary Conditions and Agreement, shall also apply to the Substantial Completion date.
12. Engineering and inspection costs incurred after the final completion date shall be paid by the Contractor to the Owner as specified in the Conditions of the Contract and Agreement.
13. Proposals may not be withdrawn for a period of 60 days after bid opening.
14. The following documents are made a condition of this Proposal:
 - A. Required Bid Security
 - B. Legal Status of Bidder
 - C. Non-Collusion Affidavit

SECTION 00 43 13
BID BOND FORM

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____ as Principal, hereinafter called the Principal, a corporation duly organized under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, _____, hereinafter called the Surety, are held and firmly bound unto the Owner, hereinafter called Owner, in the sum of _____ Dollars (\$_____) for the payment of which sum well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a Bid for WPCF Battery B Secondary Clarifier Flow Control.

NOW, THEREFORE, if the Owner shall accept the Bid of the Principal and the Principal shall enter into a Contract with the Owner in accordance with the terms of such Bid, and give such Bond or Bonds as may be specified in the Contract Documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such Contract and give such Bond or Bonds, if the Principal shall pay to the Owner the difference not-to-exceed the penalty hereof between the amount specified in said Bid and such larger amount for which the Owner may in good faith contract with another party to perform the Work covered by said Bid, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this _____ day of _____, 20__.

(Witness)

(Principal)

(Title)

(Witness)

(Surety)

(Title)

SECTION 00 43 45
LEGAL STATUS OF BIDDER

(The Bidder shall check the appropriate box and complete the information requested therein)

☐ A corporation, duly authorized and doing business under the laws of the State of Michigan, for whom _____ whose signature is affixed to this Bid, is duly authorized to execute contracts.

☐ A limited liability company, duly authorized and doing business under the laws of the State of Michigan, for whom _____, whose signature is affixed to this Bid, is duly authorized to execute contracts.

☐ A partnership, all partners with their addresses are:

☐ An individual, whose signature is affixed to this Bid.

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SECTION 00 45 13
STATEMENT OF BIDDER'S QUALIFICATIONS

This Proposal is submitted in the name of:

(Print) _____

The undersigned hereby designates the following business address to which all notices, directions or other communications may be served or mailed:

Street: _____ City: _____

State: _____ Zip Code: _____

The undersigned hereby declares their legal status as checked below:

- ☐ SOLE PROPRIETOR
- ☐ SOLE PROPRIETOR DOING BUSINESS UNDER AN ASSUMED NAME
- ☐ CO-PARTNERSHIP

The Assumed Name of the Co-Partnership is registered in the County of _____,

☐ CORPORATION INCORPORATED UNDER THE LAWS OF THE STATE OF _____.

The Corporation is:

- ☐ authorized to conduct business in the State of _____
- ☐ not now authorized to conduct business in the State of _____
- ☐ possess all required licenses for the work being bid
- ☐ limited liability corporation

The name, titles, and home addresses of all persons who are officers or partners in the organization are as follows:

Name: _____ Title: _____

Address: _____

Name: _____ Title: _____

Address: _____

Name: _____ Title: _____

Address: _____

Name: _____ Title: _____

Address: _____

Signed this _____ day of _____, 20____

By: _____

Printed Name: _____

Title: _____

SECTION 00 45 19
NON-COLLUSION AFFIDAVIT OF PRIME BIDDER

State of _____)

) ss:

County of _____)

_____, being first duly sworn, deposes and says that:

1. He/She is the of _____ (Position) of _____ (Firm) the Bidder that has submitted the attached Bid;
2. He/She is fully informed with respect to the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;
3. Such Bid is genuine and is not a collusive or sham bid;
4. Neither the Bidder nor any of its officers, partners, members, managers, owners, agents, representatives, employees or parties in interest, including this affiant, has in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, entity or person to submit a collusive or sham bid in connection with the Contract Documents for which the attached Bid has been submitted or to refrain from bidding in connection with the Contract Documents or has in any manner, directly or indirectly, sought by agreement, collusion, communication or conference with any other Bidder, entity or person to fix the price or prices in the attached Bid or that of any other Bidder or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against City of Flint, or any person or other entity interested in the proposed Contract Documents; and
5. The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees or parties having interest, including this affiant.

Name of Bidder: _____

Signed By: _____

Title: _____

Subscribed and sworn to me this _____ day of _____, 20_____.

_____ Notary Public

_____ County, Michigan

Acting in the County of: _____

My Commission Expires: _____

Notary Seal

**SECTION 00 51 00
NOTICE OF AWARD**

Attention: _____

Date: _____

Project: WPCF Battery B Secondary Clarifier Flow Control

Pursuant to the provisions of Article 1.11 of the Instructions to Bidders, you are hereby notified that the City of Flint (Owner) during a _____ Meeting held on _____, 20____ has directed the acceptance of your Bid for the above referenced Project in the amount of _____ Dollars (\$_____).

This Project consists of replacement of existing flow control valves for the four Battery B secondary clarifiers with flow meters and replacement of the RAS control and shutoff valves for each clarifier with flow meter with associated work in the flow control vault including HVAC/sump pump replacement, hatch replacement, electrical and other miscellaneous upgrades, as delineated in your Bid submitted to City of Flint on 07-20-2023.

Please comply with the following conditions within 15 days of the date of this Notice of Award; that is by _____, 20_____.

1. Deliver to Engineer _____ (_____) fully executed counterparts of the Agreement including all the Contract Documents.
2. Deliver with the executed Agreement the Contract Security (Bonds), on the form included in the Contract Documents, as specified in the General Conditions (Article 5).
3. Deliver with the executed Agreement the Insurance Certificates (and other evidence of insurance) as specified in the General Conditions (Article 5).
4. Please do not date Agreement and Contract Security (Bonds), as these will be dated by the Owner when executed by them.

It is important to comply with these conditions and time limits as failure to comply with these conditions within the time specified will entitle Owner to consider your bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

Within ten (10) days after you comply with those conditions, Owner will return to you two (2) fully signed counterparts of the Agreement with the Contract Documents attached.

In accordance with paragraph 2.05 of the General Conditions, please submit to Engineer the required schedules prior to the scheduling of a Pre-Construction Meeting.

Owner: _____

Authorized Signature: _____

Copy to Wade Trim, Inc.

SECTION 00 52 00 AGREEMENT

This Agreement, made and entered into this _____ day of _____ in the year 20____, by and between City of Flint hereinafter called Owner, and _____ hereinafter called Contractor, in consideration of the mutual covenants hereinafter sent forth, agree as follows:

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

Replacement of existing flow control valves for the four Battery B secondary clarifiers with flow meters and replacement of the RAS control and shutoff valves for each clarifier with flow meter with associated work in the flow control vault including HVAC/sump pump replacement, hatch replacement, electrical and other miscellaneous upgrades.

The Work will be substantially completed within 420 calendar days after the date when the Contract Time commences to run as provided in paragraph 2.03 of Section 00 72 00, and completed and ready for final payment in accordance with paragraph 14.11 of Section 00 72 00 within 450 calendar days after the date when the Contract Time commences to run.

Engineering and inspection costs incurred after the specified final completion date shall be paid by the Contractor to the Owner prior to final payment authorization.

1. Charges shall be made at such times and in such amounts as the Engineer shall invoice the Owner, provided however said charges shall be in accordance with the Engineer's current rate schedule at the time the costs are incurred.
2. The costs of the Engineer incurred after the specified final completion date shall be deducted from the Contractor's progress payments.

Owner and Contractor recognize that time is of the essence of this Agreement and that the Owner will suffer financial loss if the Work is not Substantially Complete within the time specified in paragraph 1.03.A above, plus any extensions thereof allowed in accordance with Article 12 of Section 00 72 00. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by the Owner if the Work is not Substantially Complete on time. Accordingly, instead of requiring any such proof, the Owner and the Contractor agree that as liquidated damages for delay (but not as penalty) the Contractor shall pay the Owner One Thousand Five Hundred Dollars (\$1,500.00) for each day that expires after the time specified in paragraph 1.03.A above for Substantial Completion until the Work is Substantially Complete.

1. Liquidated damages charged shall be deducted from the Contractor's progress payment.

Owner shall pay Contractor as provided in the attached Proposal for performance of the Work in accordance with the Contract Documents.

Progress payments and retainage under this Contract are governed by the provisions of PA 1980, No. 524 (MCLA 125.1561 et seq.). That Act is incorporated herein by reference and made a part of this Contract. Without excluding any provisions of the Act from this Contract, but in order to comply therewith and summarize certain provisions, the following shall apply:

1. The person representing the Contractor who will submit written requests for progress payments shall be: _____
2. The person representing the Owner to whom requests for progress payments are to be submitted shall be: Trevor Wagenmaker, PE - Wade Trim.
3. Contractor's representative, listed above, shall submit Applications for Payment on the form provided in the Contract Documents in accordance with Article 14 of Section 00 72 00. Applications for Payment will be processed as provided in Section 00 72 00.

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

4. Contractor has considered the nature and extent of the Contract Documents, Work, locality, and all local conditions and federal, state and local laws, and regulations that may affect cost, progress, performance, or furnishing of the Work.
5. Contractor has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work which were relied upon in the preparation of the Plans and Specifications and which have been identified in the Supplementary Conditions.
6. Contractor has made or caused to be made examinations, investigations and tests and studies of such reports and related data in addition to those referred to in paragraph 1.06.A.2 above as the Contractor deems necessary for the performance of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations, tests, reports or similar data are or will be required by the Contractor for such purposes.
7. Contractor has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.
8. Contractor has given Engineer written notice of all conflicts, errors or discrepancies that he has discovered in the Contract documents and the written resolution thereof by Engineer is acceptable to the Contractor.

The Contract Documents which comprise the entire Contract between the Owner and the Contractor are attached to this Agreement, made a part hereof and consists of the following:

1. Procurement Requirements (including the Advertisement for Bids, Instructions to Bidders, Proposal, Legal Status of Bidder, and other Documents listed in the Table of Contents thereof).
2. This Agreement
3. Performance and other Bonds
4. Notice of Award
5. Notice to Proceed (if issued)
6. Conditions of the Contract (including Section 00 72 00 - General conditions and Section 00 73 00 - Supplementary Conditions, if any)
7. Specifications contained within Division 01 through 49 of the Project Manual dated Ready for Bidders date
8. Plans consisting of sheets bearing the following general title: WPCF Battery B Secondary Clarifier Flow Control
9. Addenda numbers _____ to _____, inclusive
10. Documentation submitted by the Contractor prior to Notice of Award
11. Any Modification, including Change Orders, duly delivered after execution of Agreement.

Terms used in this Agreement which are defined in Article 1 of Section 00 72 00 shall have the meanings indicated in Section 00 72 00.

No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on any other party without the written consent of the party sought to be bound; and specifically but without limitation, monies that may become due and monies 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.

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

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 the Owner and the 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, the parties hereto have signed this Agreement in three counterparts. One (1) counterpart(s) each have been delivered to Owner and Contractor, one (1) counterpart(s) has been delivered to the Engineer. All portions of the Contract Documents have been signed or identified by Owner and Contractor.

This Agreement will be effective on ____, 20__.

Owner: City of Flint

By: _____

Authorized Signature: _____

Attest: _____

Address for giving notices:

Contractor: _____

By: _____

Authorized Signature: _____

Attest: _____

Address for giving notices:

License No. _____

Agent for service of process: _____

**SECTION 00 55 00
NOTICE TO PROCEED**

To: _____

Date: _____, 20____

Attention: _____

Project: WPCF Battery B Secondary Clarifier Flow Control

Please note that the Contract Time under the above Contract will commence to run on _____, 20____. Within ten (10) days of this date you are to start performing the Work. The dates of Substantial Completion and Final Completion are set forth in the Agreement: they are _____, and _____, respectively.

In accordance with paragraph 2.05 of the General Conditions, please submit to the Engineer the required schedules prior to the scheduling of a Pre-Construction Meeting.

Also, in accordance with paragraph 2.05 of the General Conditions, please request a Pre-Construction Meeting from the Engineer prior to delivery of any materials or start of any construction. A minimum of three (3) full working days' notice is required to set up the Pre-Construction Meeting. Also, please notify the Engineer three (3) full working days in advance of any staking requirements or other activity on the Project.

Work at the site must be started by _____, 20____.

Owner: _____

Authorized Signature: _____

Copy to Wade Trim, Inc.

SECTION 00 60 00 PROJECT FORMS

PART 1 GENERAL

1.01 AVAILABLE FORMS

- A. The following Project Forms are available for use by Owner, Contractor and/or Engineer for this project and are located in **Exhibit 1** of the Contract Documents:
1. Certificate of Substantial Completion
 2. Change Proposal
 3. Construction Change Requisition / Work Change Directive
 4. Field Order
 5. Non-Compliance Notice / Order to Remove Defective Work
 6. Open Items List
 7. Punch List Items
 8. Request for Final Inspection
 9. Request for Information
 10. Substitution Request Form
 11. Warranty Data Sheet

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 00 61 12
PERFORMANCE BOND**

Bond No. _____

KNOW ALL BY THESE PRESENT, That we, _____, a corporation organized and existing under the laws of the State of, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Obligee, and hereinafter called "Obligee," in the just and full sum of _____ Dollars (\$_____) lawful money of the United States of America, to be paid to the said Obligee, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Obligee, dated the day of _____, 20_____, for _____

_____.

Herein referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein, and

WHEREAS, it was one of the conditions of the award of the said Obligee, pursuant to which said contract was entered into, that these presents should be executed.

AND THE SAID SURETY, for value received, hereby stipulates and agrees that no change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the work to be performed thereunder or the Contract Documents accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work or to the Contract Documents.

NOW, THEREFORE, if the above Principal shall in all respects comply with the terms and conditions of said contract, and his (their or its) obligations thereunder, including the Contract Documents therein referred to and made a part thereof, and such alteration as may be made in such contract or Contract Documents, as herein or therein provided for, then this obligation shall be void; otherwise, this bond and obligation shall be and remain in full force and effect.

Signed and sealed this day of _____, 20_____.

Signed, sealed and delivered in the presence of:

Witness for Contractor: _____

_____ (Principal)

_____ (Title)

By: _____

Witness for Surety: _____

_____ (Surety)

_____ (Title)

By: _____

_____ (Attorney-in-Fact)

Seal

Address of Surety: _____

Telephone: _____

SECTION 00 61 13
LABOR AND MATERIAL PAYMENT BOND

Bond No. _____

KNOW ALL BY THESE PRESENT, That we, _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of _____, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Oblige, and hereinafter called "Obligee," in the just and full sum of _____ Dollars (\$_____) lawful money of the United States of America, to be paid to the said Oblige, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Oblige, dated the day of _____, 20____, for _____

which contract is herein referred to and made part hereof as fully and to the same extent as if the same were entirely written herein, and

WHEREAS, it was one of the conditions of the award of the said Oblige, pursuant to which said contract was entered into, that these presents should be executed.

AND WHEREAS, this Bond is given in compliance with and subject to the provisions of Act No. 213 of the Public Acts of Michigan for the year 1963, as amended, including all notices, time limitation provisions and other requirements set forth therein, which are incorporated herein by reference.

AND THE SAID SURETY, for value received, hereby stipulates and agrees that no change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work to be performed thereunder or the Contract Documents accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, or any other forbearance, alteration or addition to the terms of the contract or to the Work or to the Contract Documents.

NOW, THEREFORE, the condition of this obligation is such that if all claimants as defined in Act No. 213 of the Public Acts of Michigan for the year 1963, as amended, are timely paid for all labor and material used or reasonably required for use in the performance of the contract, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Signed and sealed this day of _____, 20_____.

Signed, sealed and delivered in the presence of:

Witness for Contractor: _____

_____ (Principal)

_____ (Title)

By: _____

Witness for Surety: _____

_____ (Surety)

_____ (Title)

By: _____

_____ (Attorney-in-Fact)

Seal

Address of Surety: _____

Telephone: _____

SECTION 00 61 19
MAINTENANCE AND GUARANTEE BOND

Bond No. _____

KNOW ALL BY THESE PRESENT, That we, _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, hereinafter called the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Owner State, as Surety, hereinafter called "Surety", are held and firmly bound unto _____, as Oblige, and hereinafter called "Obligee," in the just and full sum of _____ Dollars (\$_____) lawful money of the United States of America, to be paid to the said Oblige, to which payment well and truly to be made, we bind ourselves, our heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION is such that, WHEREAS, the above Principal has entered into a contract with the said Oblige, dated the day of _____, 20_____, for _____

Herein referred to and made part hereof as fully and to the same extent as if the same were entirely written herein, and

NOW THEREFORE, the condition of this obligation is that under the Contract Documents, ContractorC has agreed with Owner that for a period of one (1) year from the date of payment of the Final Estimate, Contractor shall keep in good order and repair any defect in the Work, either by Contractor or its Subcontractors that may develop or be discovered during said one (1) year period due to improper materials, defective equipment, workmanship, or arrangements and any other work affected in making good such imperfections. Contractor also agreed to promptly make such repairs as directed by Owner for replacement of the Work, without cost to Owner, except for such parts of the Work as may have been disturbed without the consent of Contractor after the final acceptance of the Work, whenever directed so to do by notice from Owner. If Contractor fails to make such repair within one (1) week from the date of receipt of such notice, then Owner shall have the right to purchase such materials and employ such labor and equipment as may be necessary for the purpose and to undertake, to and make such repairs and charge the cost thereof to Contractor and receive payment for the same promptly from the Contractor or Surety.

If any repair is necessary to be immediately made to protect persons or property then, and in such event, Owner may, but shall not be required to, take immediate steps to repair such defects without notice to Contractor. In such event, Owner shall not be required to obtain the lowest bid for the performance of the Work or any part thereof, and all sums actually paid therefore shall be charged to the Contractor or Surety. In this regard, the judgment of Owner shall be final and conclusive. Contractor shall, for a period of one (1) year from the date of payment of the Final Estimate, keep the Work in good order and repair, except for such parts of the Work which may have been disturbed without the consent of Contractor after the final acceptance of the Work. Contractor shall further, whenever notice is given as hereinbefore specified, promptly proceed to make the repair as in said notice directed or reimburse Owner for any cost incurred by Owner in making such repairs.

SECTION 00 62 75
ENGINEER'S CERTIFICATE FOR PAYMENT

Job Number: _____ Certificate Number: _____ Date: _____
Owner: _____ Contractor: _____
Project: _____
Contract Date: _____
Substantial Completion: _____ Extended To: _____
Final Completion: _____ Extended To: _____

Original Contract Price: _____	Total Earned To Date: _____
Adjustments to Quantities: _____	Retention: _____
Extras: _____	Deductions: _____
Total Change Orders: _____	Total Withheld: _____
Amended Contract Price: _____	Total Net Due: _____
Less Total Net Due: _____	Less Previous Certificates: _____
Balance on Contract: _____	Balance Due this Certificate: _____

ENGINEER'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on the data comprising the above application, the Engineer to the best of Engineer's knowledge, information, and belief and subject to the limitations stated in the Contract Documents certifies to the Owner that: (1) Work has progressed to the point indicated, (2) that the quality of the Work is in accordance with the Contract Documents, and (3) Contractor is entitled to payment of the Total Balance Due This Certificate.

Certified By: _____ Date: _____

SECTION 00 62 76
CONTRACTOR'S APPLICATION FOR PAYMENT

Job Number: _____ Application No: _____ Date: _____

Owner: _____ Contractor: _____

Project: _____

Contract Date: _____

Period of this Application: _____ to _____

Total Earned To Date: _____ Less Total Earned to Due: _____

Previous Certificate: _____ Total Earned this Application: _____

CONTRACTOR'S CERTIFICATION

The undersigned Contractor certifies that to the best of Contractor's knowledge, information, and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by Contractor for Work for which previous Certificates for Payment were issued and payments received from Owner, and that current payment shows herein is now due.

By: _____ Title: _____

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period covered by this Application, performed any work, furnished any material, sustained any loss, damage, or delay for any reason, including soil conditions encountered or created, or otherwise done anything for which I shall ask, demand, sue for, or claim compensation from the Owner or its agents, and the Engineer or its agents, in addition to the regular items set forth in the Contract as dated above executed between myself and the Owner and in the Change Orders for Work issued by the Owner in writing as provided thereunder, except as I hereby make claim for additional compensation and/or extension of time, as set forth on the itemized statement attached hereto.

By: _____ Title: _____

SECTION 00 62 77
PAYMENT SCHEDULE

Application No.: _____ Date: _____ Period: _____

Item of Work	Unit	Original Estimated Quantity	Unit Price	Period Quantity	Period Amount	Total Quantity to Date	Total Amount to Date

SECTION 00 63 25
SUBSTITUTION REQUEST FORM

Specification Section: _____

Specified Product: _____

Proposed Substitution: _____

Does specified product exceed, in any respect proposed substitution? ___Y ___N

Does substitution affect dimensions shown on Plans? ___Y ___N

Does substitution affect other trades more than original product? ___Y ___N

Does warranty differ from that specified? ___Y ___N

Does substitution affect cost to Owner? ___Y ___N

Does substitution result in any license fee or royalty? ___Y ___N

If you indicated "Yes" to any of the items above, attach thorough explanation on your Company letterhead, as follows:

1. Explain any differences between proposed substitution and specified product.
2. Summarize experience with product and manufacturer in Project area.
3. Attach complete technical data and literature.

The undersigned states that the function, appearance, and quality of the proposed substitution is equivalent or superior to the specified item, and that all information above and attached is true and correct.

Submitted By: _____

Signature: _____ Date: _____

Position: _____ Company: _____

Address: _____

Telephone: _____ Email: _____

SECTION 00 65 16
CERTIFICATE OF SUBSTANTIAL COMPLETION

Project: WPCF Battery B Secondary Clarifier Flow Control

Owner: City of Flint

Contractor: _____

Contract Date: _____ Project No.: _____

Date of Issuance: _____

Project or Designated Portion Shall Include: _____

The Work performed under this Contract has been reviewed and found to be Substantially Complete. The _____ which is also the date of commencement of applicable warranties required by the Contract Documents except as stated below. date of Substantial Completion of the Project or portion thereof designated above is hereby established as:

DEFINITION OF DATE OF SUBSTANTIAL COMPLETION

The date of Substantial Completion of the Work or designated portion thereof, is the date certified by the Engineer when construction is sufficiently complete, in accordance with the Contract Documents, so the Owner can occupy or utilize the Work or designated portion thereof for the use for which it is intended, as expressed in the Contract Documents.

A list of items to be completed or corrected, prepared by the Engineer is attached hereto. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. The date of commencement of warranties for items on the attached list will be the date of final payment unless otherwise agreed to in writing.

The responsibilities of the Owner and the Contractor for security, maintenance, heat, utilities, damage to the Work and insurance shall be as follows:

Owner shall have 45 days after receipt of this certificate during which he may make written objection to Engineer and Contractor as to any provisions of the certificate or attached list. Such objection may be cause for this Certificate of Substantial Completion to be null and void.

Engineer: _____

By: _____

Date: _____

SECTION 00 65 20
SWORN STATEMENT

STATE OF Michigan

COUNTY OF _____}

being duly sworn, deposes and says:

That _____ is the (Contractor) (Subcontractor)
for an improvement to the following described real property situated
in _____ County, Michigan described as follows:

Insert Legal Description of Property

That the following is a statement of each Subcontractor and Supplier and laborer, for which the payment of wages or fringe benefits and withholdings is due but unpaid, with whom the (Contractor) (Subcontractor) has (contracted) (subcontracted) for performance under the contract with the Owner or lessee thereof, and that the amounts due to the persons as of the date hereof are correctly and fully set forth opposite their names, as follows:

Name of Subcontractor/ Supplier/ Laborer	Type of Improvement Furnished	Total Contract Price	Amount Already Paid	Amount Currently Owing	Balance to Complete (optional)	Amount of Laborer Wages Due but Unpaid	Amount of Laborer Fringe Benefits and Withholdings Due But Unpaid
TOTALS:							

(Some columns are not applicable to all persons listed)

Contractor has not procured material from, or subcontracted with, any person other than those set forth on the reverse side and owes no money for the improvement other than the sums set forth on the reverse side.

Deponent further says that he or she makes the foregoing statement as the (Contractor) (Subcontractor) or as _____ of the (Contractor) (Subcontractor) for the purpose of representing to the Owner or lessee of the described on the reverse side premises and his or her agents that the property described on the reverse side is free from claims of construction liens, or the possibility of construction liens, except as specifically set forth on the reverse side and except for claims of construction liens by laborers which may be provided pursuant to Section 109 of the Construction Lien Act, Act No. 497 of the Public Acts of 1980, as amended, being section 570.1109 of the Michigan Compiled Laws.

Warning to Owner: Owner or Lessee of the property described herein may not rely on this Sworn Statement to avoid claim of a subcontractor, supplier or laborer who has provided a Notice of Furnishing pursuant to Section 109 of the Construction Lien Act to the Designee or to the Owner or Lessee if the Designee is not named or has died.

Warning to Deponent: A person, who with intent to defraud, gives a false Sworn Statement, is subject to criminal penalties as provided in Section 110 of the Construction Lien Act, Act No. 497 of the Public Acts of 1980, as amended, being Section 570.1110 of the Michigan Compiled Laws.

_____ day of _____, 20_____.

Notary Public: _____

_____ County, Michigan

My Commission Expires: _____

INSTRUCTIONS

A Sworn Statement in the preceding form must be provided before any Contractor or Subcontractor can file a Complaint, Cross-Claim, or Counter-Claim to enforce a construction lien.

An Owner or lessee may withhold payment to a Contractor or Subcontractor who has not provided a Sworn Statement. Owner or lessee may withhold from a Contractor or Subcontractor who has provided a Sworn Statement the amount sufficient to pay all sums shown on the statement as owing Subcontractors, Suppliers, and laborers, or the amount shown to be due to lien claimants who have provided Notices of Furnishing pursuant to the Construction Lien Act of 1980.

Owner or lessee may rely on a Sworn Statement to avoid a lien claim unless the lien claimant has provided the Owner or lessee with a Notice of Furnishing pursuant to the Construction Lien Act of 1980.

If the contract provides for payments by the Owner to the Contractor, if any, in the normal course of construction, but the Owner elects to pay lien claimants directly, the first time the Owner elects to make payment directly to a lien claimant he or she shall provide at least 5 business days' notice to the Contractor of the intention to make direct payment. Subsequent direct disbursements to lien claimants need not be preceded by the 5-day notice provided in this section unless the Owner first returns to the practice of paying all sums to the Contractor.

SECTION 00 65 21
PREVAILING FEDERAL WAGE RATE - DAVIS BACON ACT

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.

In case there is an omission of any trade from the list of wage and fringe benefit rates to be paid to each class of mechanic by Contractor, it shall be understood that the trades omitted shall also be paid not less than the wage and fringe benefit rates prevailing in the locality in which the work is to be performed.

A finding by the U.S. Department of Labor's Wage and Hour Division that Contractor or subcontractor is in violation of the requirements of the contract shall be final.

END OF SECTION

SECTION 00 72 00 GENERAL CONDITIONS

ARTICLE 1 DEFINITIONS

1.01 DEFINED TERMS

- A. Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:
1. Addenda -- Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the Contract Documents.
 2. Agreement -- The written Agreement between Owner and Contractor covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.
 3. Application and Certificate for Payment -- The form included in the Contract Documents which is to be used by Contractor in requesting progress or final payment and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. Bid -- The offer or proposal of the bidder submitted on the prescribed form setting forth the price(s) for the Work to be performed.
 5. Bidding Requirements -- The Advertisement for Bids, Instructions to Bidders, Supplementary Instructions to Bidders, Proposal, Legal Status of Bidder, Bid Bond, and any other documents identified in the Proposal, to be submitted with the Bid.
 6. Bonds -- Bid, Performance and Payment bonds and other instruments of security.
 7. Change Order -- A written order to Contractor, reviewed by Engineer and signed by Owner, issued after execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Price or the Contract Time. The Contract Price and Contract Time may be changed only by Change Order. A Change Order signed by Contractor indicates his agreement therewith, including that the Change Order constitutes a final adjustment in the Contract Price or Contract Time for all issues addressed or described in the Change Order.
 8. Change Proposal -- A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
 9. Claims --
 - a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.
 - b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

- c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, arising after Engineer has issued a recommendation of final payment.
 - d. A demand for money or services by a third party is not a Claim.
- 10. Constituents of Concern -- Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
- 11. Contract -- The entire and integrated written contract between Owner and Contractor concerning the Work.
- 12. Contract Documents -- Those items so designated in the Agreement, and which together comprise the Contract.
- 13. Contract Price -- The monies or other considerations payable by Owner to Contractor for completion of acceptable Work in accordance with the Contract Documents as stated in the Agreement.
- 14. Contract Time -- The number of days or the date stated in the Agreement:
 - a. to achieve Substantial Completion of all or any specified portions of the Work, and;
 - b. to complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment in accordance with paragraph 14.11.
- 15. Contractor -- The person, firm or corporation with whom Owner has entered into the Agreement.
- 16. 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 in paragraph 12.01.
- 17. Day -- A calendar day of 24 hours measured from midnight to the next midnight.
- 18. Defective -- An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to Engineer's recommendation of final payment.
- 19. Drawings -- See Plans.
- 20. Effective Date of Agreement -- The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
- 21. Electronic Document -- Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
- 22. Electronic Means -- Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow:
 - a. the transmission or communication of Electronic Documents;
 - b. the documentation of transmissions, including sending and receipt;
 - c. printing of the transmitted Electronic Document by the recipient;
 - d. the storage and archiving of the Electronic Document by sender and recipient; and

- e. the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.
- 23. Engineer -- The person, firm, or corporation identified in the Supplementary Instructions to Bidders hired by Owner to prepare Plans and Specifications for the Project and to assist Owner in interpreting Plans and Specifications during the performance of the Work. Engineer's authority and responsibility are set forth in the Contract between Owner and Engineer. Contractor acknowledges and agrees that Engineer's obligations and duties under Engineer's contract with Owner are obligations and duties to Owner only, and Engineer has no independent obligation to Contractor of any kind, including but not limited to providing services, or to take any action or to refrain from taking action on behalf of Contractor or any Subcontractor, Sub-Subcontractor or Supplier.
 - 24. Field Order -- A written order issued by Engineer which clarifies or interprets the Contract Documents or orders minor changes in the Work in accordance with paragraph 9.04 and paragraph 9.05 but which does not involve a change in the Contract Price or the Contract Time.
 - 25. Hazardous Environmental Conditions -- The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
 - a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
 - b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
 - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
 - 26. Laws and Regulations; Laws or Regulations -- Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.
 - 27. Lump Sum -- Construction Work where Owner pays a single stipulate price (Lump Sum) for the entire scope of Work; plus or minus alternates and/or allowances. However, unit prices may be required for individual items of Work for the purposes of changes, additions, or deletions.
 - 28. Milestone -- A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of the Work.
 - 29. Notice of Award -- The written notice by Owner to the apparent successful Bidder stating that, upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein, within the time specified, Owner will sign and deliver the Agreement.
 - 30. Notice to Proceed -- A written notice given by Owner to Contractor (with a copy to Engineer) fixing the date on which the Contract Time will commence to run and on which Contractor shall start to perform his obligation under the Contract Documents.
 - 31. Owner -- The public body or authority, corporation, limited liability company, association, partnership, or individual with whom Contractor has entered into the Agreement and for whom the Work is to be provided and as identified in the Supplementary Instructions to Bidders.

32. Partial Utilization -- Use by Owner of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.
33. Plans -- The part of the Contract Documents which graphically show the extent, character and Scope of the Work to be furnished and performed by Contractor and which have been prepared or approved by Engineer or Owner; sometimes also referred to as Drawings.
34. Progress Schedule -- A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
35. Project -- The total construction of which the Work to be provided under the Contract Documents may be the whole or a part as indicated elsewhere in the Contract Documents.
36. Project Manual -- The volume assembled for the Project which may include, among other parts, Procurement Requirements, Contracting Requirements and Specifications.
37. Proposal -- The offer or bid of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
38. Radioactive Material -- Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 as amended.
39. Resident Project Representative -- The authorized representative of Engineer who may be assigned to the Site or any part thereof.
40. Samples -- Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
41. Schedule of Submittals -- A schedule, prepared and maintained by Contractor, of required Submittals and the time requirements for Engineer's review of the Submittals.
42. 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.
43. Shop Drawings -- All drawings, diagrams, illustrations, schedules and other data or information required by the Contract Documents which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate material or equipment for some portion of the Work.
44. Site -- Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.
45. Specifications -- That part of the Contract Documents which consist of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.
 - a. Project Specifications are those portions of the Contract Documents which have been prepared specifically for this Project and which are identified by the job number in the lower right-hand corner of each page.
 - b. Standard Specifications are Specification sections that are the same from Project to Project as of the revision date shown in the lower left-hand corner of the page.
 - c. Standard Specification Section Revisions -- Section 00 9120 of the Specifications which amends or supplements the Standard Specification Sections.
46. Subcontractor -- An individual, firm or corporation having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

47. Submittal -- A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
48. Substantial Completion -- The Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer as evidenced by the Certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it was intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by Engineer's written recommendation of final payment in accordance with paragraph 14.11. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.
49. Supplementary Conditions -- The part of the Contract Documents which amends or supplements these General Conditions.
50. Supplementary Instructions to Bidders -- The part of the Contract Documents which amends or supplements the Instructions to Bidders.
51. Supplier -- A manufacturer, fabricator, supplier, distributor, material man, or vendor having a direct contract with Contractor, or with any Subcontractor, or with Owner, to furnish materials or equipment to be incorporated in the Work by Contractor or any Subcontractor.
52. Unit Price -- Construction Work where Owner pays a fixed sum (Unit Price) per each completed unit of Work. Units are listed on the Proposal Form.
53. Utilities -- Underground or above ground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any structures or encasements containing such facilities, which have been installed to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems, water or other liquids or chemicals.
54. Work -- The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.
55. Work Change Directive -- A written directive to Contractor, issued on or after the Effective Date of the Agreement and signed by Owner and reviewed by Engineer, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.03 or to emergencies under paragraph 6.18. A Work Change Directive will not change the Contract Price or Contract Time but is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Time as provided in paragraph 10.01.

1.02 TERMINOLOGY

- A. The following words, terms, or phrases are not defined but, when used in the Contract Documents, have the following meaning:
1. Whenever in the Contract Documents the terms “as ordered,” “as directed,” “as required,” “as allowed,” “as approved” or terms of like effect or import are used; or the adjectives “reasonable,” “suitable,” “acceptable,” “proper” or “satisfactory” or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of Engineer as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate, in general, the completed Work for compliance with the technical requirements of and information in the Contract Documents and conformance with the design concept of the completed 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 shall not be effective to assign to Engineer any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of paragraph 9.10 or any other provision of the Contract Documents.
 2. 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.
 3. 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.
 4. 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.
 5. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- B. Unless stated otherwise in the Contract Documents, words or phrases which 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 INSURANCE

- A. When Contractor delivers the executed Agreements to Owner, Contractor shall also deliver to Owner such Bonds and Insurance Certificates and other evidence of Insurance requested as Contractor may be required to furnish in accordance with Article 5. No Work at the site may begin or progress payments made to Contractor until all Bonds and Insurance Certificates in the form and substance required in Article 5 have been submitted and approved by Owner.

2.02 COPIES OF DOCUMENTS

- A. Owner shall furnish to Contractor up to five (5) copies of the Contract Documents (including at least one fully signed counterpart of the Agreement) as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

2.03 COMMENCEMENT OF CONTRACT TIME; NOTICE TO PROCEED

- A. Time is of the essence in the performance of the Work. The Contract Time will commence to run on the 30th day after the effective date of the Agreement, 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 Agreement. In no event will the Contract Time

commence to run later than the 30th day after the effective date of the Agreement. Time limits stated in the Contract Documents are of the essence of the Agreement.

2.04 STARTING THE PROJECT

- A. Contractor shall start to perform the Work within 10 days of when the Contract Time commences to run, but no Work shall be done at the Site prior to the date on which the Contract Time commences to run. Contractor shall notify Engineer at least 3 working days in advance of the time he intends to start Work.

2.05 PRECONSTRUCTION MEETING

- A. Within 10 days of the Effective Date of the Agreement and prior to the delivery of materials or the start of any construction, Contractor shall request a Preconstruction Meeting from Engineer. A minimum of 3 full working days' notice shall be required.
- B. Prior to the scheduling of the Preconstruction Meeting, Contractor shall submit to Engineer for review:
 - 1. A preliminary Progress Schedule indicating the starting and completion dates of the various stages of the Work, including any Milestones specified in the Contract Documents;
 - 2. A preliminary Schedule of Submittals which will list each required Submittal and the times for submitting, reviewing and processing such Submittal;
 - 3. An estimated monthly payment schedule, and a preliminary Schedule of Values for all of the Work.
- C. The Preconstruction Meeting will be held for review and acceptance of the schedules, to establish procedures for handling Shop Drawings and other Submittals, for processing Applications for Payment, and to establish a working understanding among the parties as to the Work.

2.06 ELECTRONIC TRANSMITTALS

- A. Except as otherwise stated elsewhere in the Contract, Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3 CONTRACT DOCUMENTS INTENT AND REUSE

3.01 INTENT

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
 - 1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations; or
 - 3. any obligation on the part of Engineer to Contractor.

3.02 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

- A. Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, or Laws or Regulations in effect at the time of opening of Bids or, on the effective date of the Agreement if there were no Bids, except as may be otherwise specifically stated in the Contract Documents.
- 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. Any Work, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result shall be furnished and performed whether or not it is specifically called for.
- C. No provision of any standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of Owner, Contractor or Engineer, or any of their Subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to Owner, Engineer or any of Engineer's consultants, agents or employees, any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of paragraph 9.10 or any other provision of the Contract Documents.

3.03 REPORTING AND RESOLVING DISCREPANCIES

- A. Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor has a duty to and shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor should reasonably have discovered and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.
- B. If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall report it to Engineer in writing at once, and, Contractor shall not proceed with the Work affected thereby (except in an emergency as authorized by paragraph 6.18) until receiving written instruction or clarification from Engineer or Owner. However, Contractor shall not be liable to Owner or Engineer for failure to report any such conflict, error, ambiguity or discrepancy unless Contractor knew or reasonably should have known thereof.

- C. Except as otherwise specifically stated in the Contract Documents or as may be provided by amendment or supplement issued by one of the methods indicated in paragraph 3.05, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and;
 - 1. the provisions of any standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents); or
 - 2. 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 CONTRACT DOCUMENTS

- A. During the performance of the Work and until final payment, Contractor and Owner shall submit to Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation - RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.
- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve
 - 1. the performance or acceptability of the Work under the Contract Documents,
 - 2. the design (as set forth in the Drawings, Specifications, or otherwise), or
 - 3. other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in paragraph 11.01.

3.05 ORDER OF PRECEDENCE

- A. In resolving conflicts, errors or discrepancies between Plans and Specifications,
 - 1. figured dimensions shall govern over scaled dimensions;
 - 2. Plans shall govern over Standard Specifications;
 - 3. and Project Specifications shall govern over Standard Specifications and Plans.

3.06 AMENDING AND SUPPLEMENTING CONTRACT DOCUMENTS

- A. The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:
 - 1. a Field Order (pursuant to paragraph 9.05), or,
 - 2. a Change Order (pursuant to paragraph 10.01.A.1), or
 - 3. a Work Change Directive Order (pursuant to paragraph 10.01.A.2)
- B. In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:
 - 1. a Field Order (pursuant to paragraph 9.05),
 - 2. Engineer's review of a Shop Drawing or Sample (pursuant to paragraph 6.21), or

3. Engineer's written interpretation or clarification (pursuant to paragraph 9.04).

3.07 REUSE OF DOCUMENTS

- A. Neither Contractor nor any Subcontractor, manufacturer, fabricator, Supplier, distributor, or other person or organization performing or furnishing any of the Work under a direct or indirect contract with Owner:
 1. shall have or acquire any title to or ownership rights in any of the Plans, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or Engineer's Consultant, and
 2. they shall not reuse any of such Plans, Specification, other documents or copies on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.

3.08 ELECTRONIC DATA

- A. Except as otherwise stated elsewhere in the Contract Documents, 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. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

4.01 AVAILABILITY OF LANDS

- A. Owner shall furnish, as indicated in the Contract Documents and not later than the established date for beginning Work on the Contract, the lands upon which the Work is to be performed, rights of way and easements for access thereto, and such other lands which are designated for the use of Contractor. Owner shall identify any encumbrances or restrictions not of general application but specifically related to use of lands so furnished with which Contractor will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by Owner, unless otherwise provided in the Contract Documents. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment unless otherwise provided in the Contract Documents.

4.02 SUBSURFACE AND PHYSICAL CONDITIONS; INVESTIGATIONS AND REPORTS

- A. Reference is made to the Supplementary Conditions for identification of those reports of investigations and tests of subsurface and physical conditions at the Site or otherwise affecting cost, progress or performance of the Work which have been reviewed in preparation of the Contract Documents. Such reports are not guaranteed as to accuracy or completeness and are not part of the Contract Documents.
- B. The locations of utilities or other physical conditions relating to existing surface or subsurface structures at or contiguous to the Site as shown on the Plans are taken from drawings from sources believed to be reliable. Neither Owner nor Engineer will be responsible for any omissions of, or variations from, the indicated location of existing utilities which may be encountered in the Work.
- C. Contractor shall draw its own conclusions as to the general accuracy of the "technical data" contained in such reports and drawings, and confirms such reports and drawings are not

Contract Documents. Contractor may not rely upon or make any Claim against Owner, Engineer or any of Engineer's Consultants 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 data, interpretations, opinions or information.
- D. The cost of all the following will be included in the Contract Price and Contractor shall have full responsibility for:
1. reviewing and checking all such information and data,
 2. locating all Utilities during construction,
 3. coordination of the Work with the owners of such Utilities, and
 4. the safety and protection of all such Utilities as provided in paragraph 6.15 and repairing any damage thereto resulting from the Work.

4.03 UNFORESEEN PHYSICAL CONDITIONS

- A. If Contractor discovers one or both of the following physical conditions of surface or subsurface at the Project or improvement Site, before disturbing the physical condition, Contractor shall immediately notify Owner and Engineer of the physical condition; and follow up within 48 hours in writing:
1. A subsurface or a physical condition at the Site differing materially from those indicated in the Contract Documents, or
 2. An unknown physical condition at the Site of a nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for the improvement project.
- 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 4.03.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding 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 4.03.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 12.03; 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 pursuant to paragraph 10.05.
- 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 4.03.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 or Work Change Directive.
- 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 Owner's written statement to Contractor regarding the subsurface or physical condition in question.

4.04 UTILITIES

- A. Contractor's Responsibilities. The information and data shown or indicated in the Contract Documents with respect to existing Utilities at or adjacent to the Site, if any, is based on information and data furnished to Owner or Engineer by the owners of such Utilities, including Owner, or by others.
 - 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 Utilities at the Site;
 - b. locating all Utilities shown or indicated in the Contract Documents as being at the Site;
 - c. coordination of the Work with the owners (including Owner) of such Utilities, during construction; and
 - d. the safety and protection of all existing Utilities at the Site, and repairing any damage thereto resulting from the Work.
- B. Notice by Contractor. If Contractor believes that an Utilities 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 6.18), 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:
1. promptly review the Utilities and conclude whether such Utilities was not shown or indicated in the Contract Documents,
 2. or was not shown or indicated with reasonable accuracy;
 3. obtain any pertinent cost or schedule information from Contractor;
 4. prepare recommendations to Owner regarding Contractor's resumption of Work in connection with the Utilities in question;
 5. 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 Utilities;
 6. and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- D. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
- E. Owner's Statement to Contractor Regarding Utilities. 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 Utilities 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.
- F. 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 Utilities 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 Utilities 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 12.03;
 - 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 4.04.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 Owner's written statement to Contractor regarding the Underground Facility in question.

4.05 REFERENCE POINTS

- A. Owner shall provide engineering surveys for construction to establish property corners, monuments, bench marks and similar reference points which in his judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for the preservation of established reference points and shall make no changes or relocations without

the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations. Reference points destroyed by negligence of Contractor will be replaced by Owner at the expense of Contractor. Construction Staking will be furnished by Owner as provided in Division 01 of the Specifications.

4.06 CONSTITUENTS OF CONCERN

- A. Owner shall be responsible for any Constituents of Concern uncovered or revealed at the Site which was not shown or indicated in Plans or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the Site. Owner shall not be responsible for any such materials brought to the Site by Contractor, Subcontractor, Suppliers or anyone else for whom Contractor is responsible.
- B. Upon discovering any such material, Contractor shall immediately:
 - 1. stop all Work in connection with such Hazardous Environmental Condition and in any area affected thereby (except in emergency as required by paragraph 6.18), and
 - 2. notify Owner and Engineer (and 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 Hazardous Environmental Condition or take corrective action, if any.
- C. Contractor shall not be required to resume Work in connection with such Hazardous Environmental Condition or in any such affected areas until after Owner has obtained any required permits related thereto and delivered to Contractor special written notice:
 - 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.
- D. If Owner and Contractor cannot agree as to entitlement to, or the amount, or extent of an adjustment, if any, in Contract Price or Contract Terms as a result of such Work stoppage or such special conditions under which Work is agreed by Contractor to be resumed, either party may make a Claim therefor as provided in paragraph 11.01.
- E. If after receipt of such special 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 such portion of the Work that is in connection with such condition, or in such affected area, to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to, or the amount, or extent of an adjustment, if any, in Contract Price or Contract Time as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in paragraph 11.01. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with paragraph 7.01.
- F. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, Engineer, Engineer's Consultants and the officers, directors, employees, agents, other consultants and subcontractors of each and any of them from and against all claims, costs, losses, damages and expenses arising out of or resulting from such condition per this paragraph 4.06, provided that:
 - 1. 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, and
 - 2. nothing in this paragraph 4.06 shall obligate Owner to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.
- G. The provisions of paragraph 4.03 are not intended to apply to the presence of Constituents of Concern or Hazardous Environmental Conditions uncovered or revealed at the Site.

ARTICLE 5 BONDS AND INSURANCE

5.01 PERFORMANCE AND OTHER BONDS

- A. Contractor shall furnish performance and payment Bonds, on the form included in the Contract Documents, 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 Documents. These Bonds shall remain in effect at least until 1 year after the date when final payment becomes due, except as otherwise provided by Laws and Regulations or as specified in the Contract Documents or Bond. Contractor shall also furnish such other Bonds as are required by the Supplementary Conditions.
- B. All Bonds shall be in the forms prescribed by the Contract Documents and be executed by such Sureties as
 - 1. are licensed to conduct business in the state where the Project is located, and
 - 2. are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the U.S. Department of Treasury, Financial Management Service, Surety Bond Branch.
- C. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.
- D. If Surety on any Bond furnished by Contractor is declared as bankrupt or becomes insolvent, or its right to do business is terminated in any state where any part of the Project is located, or it ceases to meet the requirements of clauses (1) and (2) of paragraph 5.01, Contractor shall within 5 days thereafter substitute another Bond and Surety, both of which shall be acceptable to Owner.

5.02 LICENSED INSURERS AND SURETIES

- A. Bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue Bonds or insurance policies for the limits and coverages so required.

5.03 INSURANCE

- A. Contractor shall purchase and maintain during the term of the Project such insurance as will protect him, Owner(s) and Engineer(s) from Claims arising out of the Work described in this Contract and performed by Contractor, Subcontractor(s) or Sub subcontractor(s) consisting of:
 - 1. Workers' Compensation Insurance including Employer's Liability to cover employee injuries or disease compensable under the Workers' Compensation Statutes of the states in which Work is conducted under this Contract; disability benefit laws, if any; or Federal compensation acts such as U.S. Longshoremen or Harbor Workers', Maritime Employment, or Railroad Compensation Act(s), if applicable. Self-insurance plans approved by the regulatory authorities in the state in which Work on this Project is performed are acceptable.
 - 2. An occurrence form Commercial General Liability policy to cover bodily injury to persons other than employees and for damage to tangible property, including loss of use thereof, plus appropriate endorsements to protect Owner and Engineer against Claims, demands, and lawsuits from employees of Contractor and Subcontractors, including the following exposures:
 - a. All premises and operations.
 - b. Explosion, collapse and underground damage.

- c. Contractor's Protective coverage for independent contractors or Subcontractors employed by him.
 - d. Broad form blanket, contractual liability for the obligation assumed in the Indemnification or Hold Harmless agreement found in the General Conditions or Supplementary Conditions of this Contract.
 - e. Personal Injury Liability endorsement with no exclusions pertaining to employment.
 - f. Products and Completed Operations coverage. Coverage shall extend through the Contract guarantee period.
 - g. Broad form property damage.
 - h. Cross liability endorsement.
 - i. For design professional additional insureds, ISO Endorsement CG 20 32 04 13, "Additional Insured-Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.
3. Comprehensive Automobile Liability policy to cover bodily injury and property damage arising out of the ownership, maintenance or use of any motor vehicle, including owned, non-owned and hired vehicles. Comprehensive General Liability and the Comprehensive Auto Liability shall be written by the same insurance carrier, though not necessarily in one policy.
 4. Contractor shall purchase for Owner an Owner's Protective Liability policy to protect Owner, Engineer, their consultants, agents, employees and such public corporations in whose jurisdiction the Work is located for their liability for Work performed by Contractor, the Subcontractor(s) or the Sub subcontractor(s) under this Contract.
 5. When a limit of liability is identified in the Supplementary Conditions, Contractor shall purchase a Builder's Risk Installation Floater in a form acceptable to Owner covering property of the Project for the full cost of replacement as of the time of any loss which shall include, as named insureds,
 - a. Contractor,
 - b. all Subcontractors,
 - c. all Sub subcontractors,
 - d. Owner, and Engineer(s) or Architect(s), as their respective interests may prove to be at the time of loss, covering insurable property which is the subject of this Contract, whether in place, stored at the Site, stored elsewhere, or in transit at the risk of the insured(s).
 - e. Coverage shall be effected on an "All Risk" form including, but not limited to, the perils of fire, wind, vandalism, collapse, theft, flood and earthquake, with removal of passive design error exclusion. Except as may otherwise be required by Owner, Contractor may arrange for such deductibles as Contractor deems to be within Contractor's ability to self-assume, but Contractor will be held solely responsible for the amount of such deductible and for any co-insurance penalties. Any insured loss shall be adjusted with Owner and Contractor and paid to Owner and Contractor as Trustee for the other insureds.
 6. Umbrella or Excess Liability:
 - a. Contractor is granted the option of arranging coverage under a single policy for the full limit required or by a combination of underlying policies with the balance provided by an Excess or Umbrella Liability policy equal to the total limit(s) requested. Umbrella or Excess policy wording shall be at least as broad as the primary or underlying policy(ies) and shall apply both to Contractor's General Liability and Automobile Liability Insurance and shall be written on an occurrence basis.

7. Railroad Protective Liability:

- a. Where any of the Work is within a railroad right-of-way or where a limit of liability is identified in the Supplementary Conditions, Contractor will provide coverage in the name of each railroad company having jurisdiction over rights of way across which Work under the Contract is to be performed. The form of policy and the limits of liability shall be determined by the railroad company(ies) involved. See Section 00 73 00 - Supplementary Conditions for limits and coverage requested.

8. Contractor's Professional Liability Insurance:

- a. 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 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.

B. Owner's responsibilities in respect of purchasing and maintaining insurance are set forth below:

- 1. Owner shall assume responsibility for such boiler and machinery insurance as may be required or considered to be necessary by Owner in the course of construction, testing or after completion.
 - a. Owner shall assume responsibility for such insurance as will protect Owner against any loss of use of Owner's property due to those perils insured pursuant to paragraph 1 above.

5.04 LIMITS OF LIABILITY

- A. The required limits of liability for insurance coverages required in paragraphs 5.03 shall be not less than those specified in Section 00 73 00 - Supplementary Conditions .

5.05 NOTICE OF CANCELLATION OR INTENT NOT TO RENEW

- A. Policies will be endorsed to provide that at least 30 days written notice shall be given to Owner and to Engineer of cancellation, intent not to renew, or material modification of the coverage.

5.06 EVIDENCE OF COVERAGE

- A. Prior to commencement of the Work, Contractor shall furnish to Owner and Engineer, Certificates of Insurance in force on current Accord® Certificate of Insurance form. Other forms of Certificate are acceptable only if;
 - 1. they include all of the items prescribed in the current Accord® Certificate of Insurance form, including agreement to cancellation provisions outlined in paragraph 5.05 above; and
 - 2. they have approval of Owner and Engineer.
- B. Prior to the commencement of the Work, Contractor shall furnish to Owner complete "originally signed" copies of the Owner's Protective Liability Policy. The number of copies shall be the same as the number of counterparts of the Agreement. Owner reserves the right to request complete copies of other policies if deemed necessary to ascertain details of coverage not provided by the certificates. Such policy copies shall be "Originally Signed Copies," and so designated.

5.07 QUALIFICATION OF INSURERS

- A. In order to determine financial strength and reputation of insurance carriers, all companies providing the coverages required shall be licensed or approved by the Insurance Bureau of the state in which the Project is located and shall have a financial rating not lower than XI and a policyholder's service rating no lower than B+ as listed in A.M. Best's Key Rating Guide, current edition. Companies with ratings lower than B+:XI will be acceptable only upon written consent of Owner.

5.08 DAMAGE CLAIMS - ACKNOWLEDGMENT AND REPORTS

- A. Contractor shall furnish to Owner an acknowledgment receipt from the insurance carrier for each damage claim against the Project. The receipt shall include the insurance carrier's assigned claim number.
- B. Upon request, Contractor or his insurance carrier shall also furnish to Owner a status report on all damage claims. This report shall include inspections made, the disposition of claims, and what action has been taken towards settlement of each claim.
- C. Failure of Contractor to comply with this paragraph 5.08 may result in the amount of such damage claims being withheld from Contractor's monthly pay estimate. Such withholding shall be reimbursed in the monthly pay estimate following compliance with this paragraph.

5.09 COST OF INSURANCE

- A. The unit cost of the insurance herein specified will not be a specific bid item, but the cost of such insurance will be included by Contractor in the various prices bid.

5.10 WAIVER OF RIGHTS

- A. Owner and Contractor intend that all policies purchased in accordance with paragraph 5.03 will protect Owner, Contractor, Subcontractors, Engineer, Engineer's Consultants (and all other persons or entities identified in the Supplementary General Conditions to be listed as insureds or additional insureds in such policies) and will provide primary coverage for all losses and damages caused by the perils covered thereby. Such policies shall contain provisions to
- B. the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder.
- C. Owner and Contractor waive all rights against each other and their respective officers, directors, employees and agents for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work; and in addition, waive all such rights against Subcontractors, Engineer, Engineer's Consultants and any other persons or entities identified in the Supplementary General Conditions to be listed as insureds or additional insureds under such policies for loss 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 as trustee or otherwise payable under any policy so issued.

5.11 RECEIPT AND APPLICATION OF INSURANCE PROCEEDS

- A. Any insured loss under the policies of insurance required by paragraph 5.03.A.5 will be adjusted with Owner and made payable to Owner as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause. If no other special agreement is reached the damaged Work shall be repaired or replaced, the monies so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order, Field Order or Work Change Directive.
- B. Owner as fiduciary shall have power to adjust and settle any loss under the policies required by paragraph 5.03.A.5 with the insurers unless one of the parties in interest shall object in writing within fifteen days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the

parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers.

ARTICLE CONTRACTOR'S RESPONSIBILITIES

6.01 SUPERVISION AND SUPERINTENDENCE

- A. Contractor shall supervise 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. Contractor shall be responsible to see that the finished Work complies with the Contract Documents. However, if specific means, methods, techniques, sequences and procedures of construction are prescribed in the Plans or Specifications, Contractor shall be responsible to comply therewith, but may implement such prescribed Work in a manner of Contractor's choosing so long as the Work complies with the requirements of the Plans and Specifications.
- B. At all times during the progress of the Work, Contractor shall assign and maintain a competent superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances. Any superintendent or foreman who neglects to have Work done in accordance with the Plans and Specifications shall be removed from the Project. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to the superintendent shall be as binding as if given to Contractor.

6.02 LABOR AND WORKING HOURS

- A. Contractor shall provide competent, suitably qualified personnel in their various duties. Contractor shall at all times maintain good discipline and order at the Site. Except as otherwise required for the safety or protection of persons, the Work, property at the Site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the Site shall be performed during regular working hours (7:00 a.m. to 7:00 p.m.), and Contractor will not permit the performance of Work on Sunday or any legal holiday without Owner's written consent given after prior written notice to Engineer.

6.03 SERVICES, MATERIALS AND EQUIPMENT

- A. Unless otherwise specified in the Contract Documents, Contractor shall furnish 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 furnishing, performance, testing, start up and completion of the Work.
- B. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Contract Documents 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 kind and quality of materials and equipment to be incorporated in the Work. Contractor shall not use material in the Work until Shop Drawing or Submittals have been reviewed by Engineer. All materials which do not meet the requirements of the Specifications at the time they are to be used will be rejected, and unless otherwise permitted by Engineer, shall be plainly marked and removed immediately from the Work.
- C. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, Supplier or distributor, except as otherwise provided in the Contract Documents.

6.04 SUBSTITUTES AND "OR-EQUALS"

- A. Whenever an item of materials or equipment is specified or described in the Contract Documents for installation in the Work by using the name of a proprietary item or the name of a

particular manufacturer, fabricator, supplier or distributor; or means, methods, techniques, sequences and procedures of construction are prescribed in the Plans or Specifications; the specification or description is intended to establish the type, function and quality required or the means, methods, techniques, sequences and procedures of construction required. Unless the specification or description contains or is followed by words indicating that no like, equivalent or "or-equal" item or no substitution is permitted, other items of material or equipment or materials or equipment of other manufacturers, fabricators, suppliers or distributors; or other means, methods, techniques, sequences and procedures of construction may be accepted by Engineer under the following circumstances:

1. "Or-Equal": If in Engineer's sole discretion 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, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items.
 2. Substitute Items: If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under paragraph 6.04.A; or a proposed means, methods, techniques, sequences and procedures of construction are different from what is prescribed in the Plans or Specifications, it will be considered a proposed substitute item.
- B. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment or means, methods, techniques, sequences and/or procedures proposed is essentially equivalent to that named and an acceptable substitute therefor. The procedure for review by Engineer will include the following, as supplemented in the Specifications, and as Engineer may decide is appropriate under the circumstances. Requests for review of substitute items of material and equipment will not be accepted by Engineer from anyone other than Contractor.
- C. If Contractor wishes to furnish or use a substitute, Contractor shall make written application to Engineer on the Substitution Request Form provided for acceptance thereof, certifying that the proposed substitute will:
1. perform adequately the functions and achieve the results called for by the general design,
 2. be similar in substance to that specified,
 3. and be suited to the same use and capable of performing the same function as that specified.
 4. The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice Contractor's achievement of Substantial Completion on time, whether or not acceptance of the proposed substitute for use in the Work will require a change in the Contract Documents (or in the provisions of any other direct contract with Owner for work on the Project) to adapt the design to the proposed substitute, and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.
- D. All variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair and replacement service shall be indicated. The application shall also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which shall be considered by Engineer in evaluating the proposed substitute. Engineer may require Contractor to furnish additional data about the proposed substitute.
- E. All data to be provided by Contractor in support of any proposed "or-equal" or substitute item will be at Contractor's expense. Engineer will be the sole judge of acceptability, and Engineer's determination shall be final and binding, may not be reversed through an appeal under any

provisions of the Contract Documents, and no "or-equal" or substitute shall be ordered, installed or utilized without Engineer's prior written acceptance. Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any "or-equal" or substitute which has been approved by Engineer.

- F. Engineer will record time required by Engineer and Engineer's consultants in evaluating substitutions proposed by Contractor and in making changes in the Contract Documents occasioned thereby. Whether or not Engineer accepts a proposed substitute, Contractor shall reimburse Owner for the charges of Engineer and Engineer's consultants for evaluating any proposed substitute and in making any changes in the Contract Documents resulting therefrom.

6.05 CONCERNING SUBCONTRACTORS

- A. Contractor shall not employ any Subcontractor, Supplier or other person or organizations, including those who are to furnish the principal items of materials or equipment, whether initially or as a substitute, against whom Owner or Engineer may have reasonable objection. Contractor shall furnish Engineer a complete list of any Subcontractor, Supplier or other person or organization furnishing principal items of material or equipment within 4 days of request. Failure to object to any Subcontractor, Supplier, other person or organization by Owner or Engineer shall not constitute a waiver of any right of Owner or Engineer to reject defective Work.
- B. If Owner or Engineer, after due investigation, has reasonable objection to any Subcontractor, Supplier, other person or organization proposed by Contractor after the Notice of Award, Contractor shall submit an acceptable substitute and the Contract Price shall be increased or decreased by the difference in cost occasioned by such substitution, and an appropriate Change Order shall be issued. Contractor shall not be required to employ any Subcontractor, Supplier, other person or organization against whom Contractor has reasonable objection.
- C. Contractor shall not award Work to Subcontractor(s), in excess of 50% of the Contract Price, without prior written approval of Owner.
- D. Contractor shall be fully responsible for all acts and omissions of his Subcontractors, Suppliers and of persons and organizations performing or furnishing any of the Work under a direct or indirect contract with Contractor just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any Subcontractor, Supplier or other person or organization. Owner or Engineer may furnish to any Subcontractor, Supplier or other person or organization, to the extent practicable, evidence of amounts paid to Contractor on account of specific Work done.
- E. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with Contractor. Contractor shall require all Subcontractors, Suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with Engineer through Contractor.
- F. If the amount of the subcontract or the nature of the Work to be performed thereunder warrants, Owner may require Subcontractor to furnish, for the benefit of Owner and Contractor jointly, Bonds in an amount proportioned to the amount of his subcontract, and for the same purpose and under the same specifications as those of the general Contract. The Surety on the general Contract shall not be eligible to furnish such Subcontract Bonds.
- G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as and additional insured on the property insurance

provided in paragraph 5.03.A.5, the agreement between Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, Engineer's Consultants and all other additional insureds for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same. Contractor shall file a true copy of such agreement with Owner.

6.06 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 Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Contractor shall defend, indemnify and hold harmless Owner and Engineer and anyone directly or indirectly employed by either of them from and against all claims, costs, losses, damages and expenses arising out of or resulting from 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, and shall defend all such claims in connection with any alleged infringement of such rights.

6.07 PERMITS AND LICENSES

- A. 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, permit, review, and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Contractor shall pay all charges of utility owners for connections to the Work.

6.08 LAWS AND REGULATIONS

- A. Contractor shall give all notices and comply with all laws, ordinances, rules, and regulations applicable to furnishing and performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws, ordinances, rules, and Regulations.
- B. If Contractor performs any Work that is contrary to such laws, ordinances, rules and regulations, Contractor shall bear all claims, costs, losses, damages and expenses caused by, arising out of, or resulting therefrom. However, it shall not be Contractor's primary responsibility to make certain that the Specifications and Plans are in accordance with such laws, ordinances, rules, 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.

6.09 TAXES

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

6.10 USE OF PREMISES

- A. Contractor shall confine construction equipment, the storage of materials and equipment and the operations of workers to the Project Site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws and Regulations, rights of way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area or to the owner or occupant thereof or of any adjacent land or areas resulting from the performance of the Work. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with any such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law. Contractor's continuing obligations under paragraph 6.24 shall be applicable to any claim hereunder.

6.11 REMOVAL OF DEBRIS AND CLEANING

- A. During the progress of the Work, Contractor shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work Contractor shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the Site clean and ready for occupancy by Owner at Substantial Completion of the Work. Contractor shall restore to their original condition all property not designated for alteration by the Contract Documents. If Contractor shall fail to keep the above noted areas cleaned of dust or debris resulting from Contractor's operations, Contractor shall be so notified in writing by Engineer. If within 24 hours after receipt of such notice Contractor shall fail to clean such areas satisfactorily, Owner may have such other agency as he shall designate, perform the work and all costs of such cleaning shall be paid for by Contractor.

6.12 LOADING STRUCTURES

- A. 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 property to stresses or pressures that will endanger it.

6.13 PROTECTION OF UTILITIES

- A. When it is possible for construction operations to endanger any public or private utility, conduit, or structure, Contractor shall notify the utility owner of this possibility, and safeguard and support such utilities, conduits, or structures. Where it is the policy of any utility owner to make its own repairs to damaged conduit or other structures, Contractor shall cooperate to the fullest extent with the utility, and he shall see that his operations interfere as little as possible with these operations, and Contractor shall assume the cost of any charge against Owner therefor. In cases where existing Utilities or Utility service connections are encountered, Contractor shall perform his operations in such a manner that service will be uninterrupted, and the cost thereof shall be at Contractor's expense, unless otherwise provided.

6.14 RECORD DOCUMENTS

- A. Contractor shall maintain in a safe place at the Site 1 record copy of all Specifications, Plans, Addenda, Change Orders, Work Change Directives, and Field Orders, in good order and annotated to show all changes made during construction. These record documents together with all Samples and all Shop Drawings shall be available to Engineer for examination and shall be delivered to Engineer for Owner upon completion of the Work.

6.15 SAFETY AND PROTECTION

- A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. 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 Work Site or who may be affected by the Work,
 - 2. all the Work and materials or 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, and Utilities and not designated for removal, relocation or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property, Utilities, and utility owners when prosecution of the Work may affect them.
- C. Contractor shall restore, at his own expense, any public or private property damaged or injured in consequence of any act or omission on his part, or on the part of his employees or agents, to a condition equal or better than that existing before such injury or damage was done. If Contractor neglects to restore or make good such damages or injury, Owner may, upon 48 hours' notice, proceed to restore or make good such damage or injury and to order the cost thereof deducted from any monies that are due, or may become due, to Contractor for this Work.
- D. Contractor's duties and responsibilities for the safety and protection of the Work 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 14.11 that the Work is Acceptable.
- E. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- F. 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.
- G. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with paragraph 14.11 that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- H. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

6.16 SAFETY REPRESENTATIVE

- A. Contractor shall be responsible to designate for itself and its employees, and its Subcontractors 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.

6.17 HAZARD COMMUNICATION PROGRAM

- A. Contractor shall be responsible for coordinating any exchange of 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 applicable Laws or Regulations.

6.18 EMERGENCIES

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor, without special instruction or authorization from Owner or Engineer, 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. 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 to document the consequences of such action.

6.19 SHOP DRAWINGS AND SAMPLES

- A. Contractor shall submit Shop Drawings required by the Contract Documents to Engineer for review, in accordance with an accepted schedule. All Submittals will be identified as Engineer may require and in the number of copies specified in the Specifications. The 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 materials and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by paragraph 6.21.
- B. Contractor shall also submit all samples required by the Contract Documents to Engineer for review in accordance with an accepted schedule. Each Sample will be identified clearly 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 6.21. The number of each sample to be submitted will be as specified in the Specifications.

6.20 SUBMITTAL PROCEDURES

- A. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:
 - 1. all field measurements, quantities, dimension, specified performance criteria, installation requirements, manufacturer's recommendations, material, catalog numbers and similar information with respect thereto,
 - 2. all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work, and
 - 3. all information relative to Contractor's responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.
- B. Contractor shall have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.
- C. Each Submittal will bear a stamp or specific written indication that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to review and approval of that Submittal.
- D. At the time of each submission, Contractor shall in writing call Engineer's attention to any deviations that the Shop Drawings or Samples may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review of each such variation.
- E. 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. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

- F. 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 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.
- G. 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.

6.21 ENGINEER'S REVIEW

- A. Engineer will review Shop Drawings and Samples in accordance with the Schedule of Submittals accepted by Engineer as required by paragraph 2.05. Engineer's review shall be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto. The review of a separate item as such will not indicate review of the assembly in which the item functions.
- B. Engineer's review of Shop Drawings or samples shall not relieve Contractor from responsibility for any variations from the Contract Documents unless Contractor has in writing called Engineer's attention to such variation at the time of submission and Engineer has given written concurrence to the specific variation, nor shall any concurrence by Engineer relieve Contractor from responsibility for errors or omissions in the Shop Drawings. Engineer's review shall not relieve Contractor from responsibility for complying with the requirements of paragraph 6.20.
- C. Where a Shop Drawing or sample is required by the Contract Documents or the Schedule of Submittals accepted by Engineer per paragraph 2.05, no related Work shall be commenced until the Submittal has been reviewed by Engineer.

6.22 CONTINUING THE WORK

- A. 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, except as Contractor and Owner may otherwise agree in writing.

6.23 CONTRACTOR'S GENERAL WARRANTY AND GUARANTEE

- A. Contractor warrants and guarantees to Owner, Engineer, and Engineer's Consultants that all work will be in accordance with the Contract Documents and will not be defective. Contractor's warranty and guarantee excludes defects or damage caused by:
 - 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or their employees, agents, or representatives, or any person or entity for whom Contractor is responsible; or
 - 2. normal wear and tear under normal usage.
- B. 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 of any progress or final payment by Engineer;
 - 3. the issuance of a certificate of Substantial Completion or any payment by Owner to Contractor under the Contract Documents;
 - 4. use or occupancy of any part of the Work by Owner;

5. any acceptance by Owner or failure to do so;
 6. any review or approval of a Shop Drawing or Sample Submittal or the issuance of a notice of acceptability by Engineer per paragraph 14.11;
 7. any inspection, test or approval by others; or
 8. any correction of defective Work by Owner.
- C. If Contract requires 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.
 - D. Contractor shall assign to Owner all warranties extended to Contractor by material Suppliers and Subcontractors. If an assignment of warranty requires the material Supplier or Subcontractor to consent to same, then Contractor shall secure the material Supplier's or Subcontractor's consent to assign said warranties to Owner.
 - E. The warranties provided in this section shall be in addition to, and not in limitation of, any other warranty or remedy required by law.

6.24 INDEMNIFICATION

- A. To the fullest extent permitted by law, Contractor shall indemnify, defend (with counsel acceptable to Owner) and hold harmless Owner, Engineer and any additional indemnitees identified in the Supplementary Conditions and their respective directors, officers, members, partners, affiliates, employees, agents and successors, from and against any and all liabilities, claims, causes of action, lawsuits, liens, injuries, damages, losses and expenses (collectively "Demands") to the extent caused by, arising out of, resulting from or occurring in connection with:
 1. Contractor's breach of, or failure to comply with, the Agreement, the Contract Documents, or any other contract that it enters into regarding the Work, including any default in performance; or
 2. Personal injury or death to any person (including, but not limited to, Contractor, Contractor's employees, Subcontractors, Subcontractors' employees, and material Suppliers) or injury to or destruction of property (including claims for loss of use) caused by, arising out of, resulting from, or in any way connected with
 - a. the Work,
 - b. any activity associated with the Work, or
 - c. the operations or acts of commission or omission of Contractor, Contractor's employees, Subcontractors, Subcontractors' employees, material suppliers, or anyone for whom Contractor is legally liable in the performance of Work, whether arising before or after completion of the Work.
- B. To the extent caused by, arising out of, resulting from, or occurring in connection with the provisions of the above paragraph 6.24.A, Contractor's indemnity obligations under this Agreement shall include, but are not limited to:
 1. Indemnity for all damages and judgment interest, all costs and fees, including, but not limited to, all defense costs, expenses and actual attorneys' fees, and all settlement payments relating to, arising out of, resulting from or in any way connected with any demand requiring indemnity by this Agreement;
 2. All expenses, including but not limited to, costs, expenses and actual attorneys' fees, incurred in securing and enforcing indemnity from Contractor if Contractor fails or refuses promptly to fulfill any of the indemnity obligations under this Agreement;

3. All indemnification obligations imposed upon Owner or Engineer, or both, arising out of or in connection with the Work; and
 4. Indemnification for any penalties and/or fines arising or resulting from Contractor's or any Subcontractor's failure to comply with laws and/or regulations applicable to its/their Work.
- C. Contractor's duty to indemnify under subpart A.2. of paragraph 6.24 is limited to the negligence of Contractor, Contractor's employees, Subcontractors, Subcontractor's employees, material Suppliers, or anyone for whom Contractor is legally liable in the performance of the Work, whether arising before or after the completion of the Work.
 - D. The indemnification rights under this Agreement shall not be construed to negate, abridge, or otherwise reduce any other right or obligations of indemnity which would otherwise exist.
 - E. Owner, at its option, may select counsel to defend any demand brought against it without impairing any obligation of Contractor to provide indemnification.
 - F. The indemnification provisions under this Agreement shall survive the completion or termination of this Agreement.
 - G. In the case of claims by any employee of Contractor, anyone directly or indirectly employed by Contractor, or anyone for whose acts Contractor may be liable, the indemnification obligations under this Agreement 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 under workers' compensation acts. Such obligations shall not be construed to negate, abridge or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Agreement.
 - H. Indemnification, additional insured and hold harmless obligations of Contractor and Subcontractor under the Contract Documents shall survive the termination of this Agreement.
 - I. Contractor and Subcontractors will compel their insurance company to waive subrogation against Owner, Engineer and Contractor and Subcontractors identified as additional insureds in the Contract Documents, including any municipal entity now existing or newly created during the term of the Contract Documents.

6.25 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 or 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, equipment, structures, means, methods, techniques or sequences of construction 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 professional properly licensed in the state in which the project is located, 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.
- D. Pursuant to this paragraph 6.25, Engineer's review or 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 or approval of Shop Drawings and other Submittals (except design calculations and design drawings) will be only for the purpose stated in paragraph 6.21.

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

ARTICLE 7 WORK BY OTHERS

7.01 RELATED WORK AT SITE

- A. In addition to and apart from the Work under the Contract Documents, 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 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 any part of Contractor's Work depends on proper execution or results upon the work of any such other contractor or utility owner, Contractor shall inspect and promptly report to Engineer in writing any delays, defects or deficiencies in such other work that render it unavailable, or unsuitable for such proper execution and results of Contractor's Work. Contractor's failure to so report shall constitute an acceptance of the other work as fit and proper for integration with Contractor's Work except for latent or non-apparent defects and deficiencies in the other work.
- C. Contractor shall afford each contractor who is party to such a direct contract, and each utility owner, (and Owner, if Owner is performing the additional work with Owner's employees), proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work and shall properly connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, Contractor shall do all cutting, fitting and patching of Contractor's Work that may be required to make its several parts come together properly and integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of Engineer and the others whose work will be affected.
- D. If the performance of additional work by other contractors, utility owner, or Owner was not noted in the Contract Documents, written notice thereof shall be given to Contractor prior to starting any such additional work. If Contractor believes that the performance of such additional work by Owner or others involves additional expense to Contractor, or requires an extension of the Contract Time, Contractor may make a Claim therefor as provided in paragraph 11.01. Claims for delay or inconveniences due to operations of such other parties for work noted in the Contract Documents will not be allowed.

ARTICLE 8 OWNER'S RESPONSIBILITIES

8.01 COMMUNICATION TO CONTRACTOR

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

8.02 REPLACEMENT OF ENGINEER

- A. In case of termination of the employment of Engineer, Owner shall appoint an engineer against whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 FURNISHING DATA

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

8.04 PAY WHEN DUE

- A. Owner shall make payments to Contractor promptly after they are due as provided in paragraphs 14.05 and 14.11.

8.05 LANDS AND EASEMENTS; REPORTS AND TESTS

- A. Owner's duties in respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of investigations and tests of subsurface and latent physical conditions at the Site.

8.06 CHANGE ORDERS

- A. In connection with Owner's rights to request changes in the Work in accordance with Article 10, Owner (especially in certain instances as provided in paragraph 10.01) is obligated to execute Change Orders.

8.07 INSPECTIONS, TESTS, AND APPROVALS

- A. Owner's responsibility in respect to certain inspections, tests and approvals is set forth in paragraph 13.02.

8.08 LIMITATION ON OWNER'S RESPONSIBILITY

- A. 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 furnishing or performance of the Work. Owner will not be responsible for Contractor's failure to perform or furnish the Work in accordance with the Contract Documents.

8.09 UNDISCLOSED HAZARDOUS MATERIALS

- A. Owner's responsibility in respect of undisclosed Constituents of Concern uncovered or revealed at the Site is set forth in Paragraph 4.06.

8.10 OWNER'S DESIGNATED REPRESENTATIVE

- A. Owner shall designate a person to act as its representatives during the performance of the Work. Owner's designated representative will attend meetings and perform on behalf of Owner all obligations required of Owner under the provisions of the Contract Documents.

ARTICLE 9 ENGINEER'S STATUS DURING CONSTRUCTION

9.01 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 shall be as set forth in the Contract Documents.

9.02 VISITS TO SITE

- A. Engineer may make visits to the Site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed Work, and to determine solely for the benefit of Owner, in general, if the Work is proceeding in accordance with the technical requirements of the Contract Documents. It will not be the responsibility of Engineer to make exhaustive or continuous on Site inspections to check the quality or quantity of the Work.

9.03 RESIDENT PROJECT REPRESENTATIVE

- A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more continuous observation of the Work. A Resident Project Representative will act as directed by and under the supervision of Engineer and will confer with Engineer regarding his actions. Resident Project Representative's dealings in matters pertaining to the on Site Work shall in general be only with Engineer and Contractor, and dealings with Subcontractors shall only be through or with the full knowledge of Contractor. The Resident Project Representative's duties and responsibilities include:

1. Schedules:

- a. Review the Progress Schedule, Schedule of Submittals and Schedule of Values prepared by Contractor.
2. Conferences:
 - a. Arrange a schedule of progress meetings and other job conferences as required in consultation with Engineer and Owner, and notify those expected to attend in advance.
3. Liaison:
 - a. Serve as Engineer's liaison with Contractor, working principally through Contractor's superintendent and assist him in understanding the intent of the technical aspects of the Contract Documents. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on Site operations.
4. Shop Drawings and Samples:
 - a. Advise Engineer and Contractor, or Contractor's superintendent, immediately of the commencement of any Work requiring a Shop Drawing or Sample submission if the submission was identified on the schedule and has not been reviewed by Engineer.
5. Review of Work, Rejection of Defective Work, Inspections, and Tests:
 - a. Conduct on Site observations of the Work and report to Engineer whenever Resident Project Representative believes that technical aspects of any executed Work is unsatisfactory, faulty or defective or does not meet the requirements of any inspections, tests or approval required to be made or has been damaged prior to final payment; and advise Engineer when Resident Project Representative believes that any partially completed portion of the Work should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
 - b. Observe, record and report to Engineer appropriate details relative to test procedures and startups.
 - c. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the outcome of these inspections and report to Engineer.
6. Modifications:
 - a. Consider Contractor's suggestions for modifications in Plans or Specifications and report them to Engineer.
7. Reports:
 - a. Prepare periodic reports as required of progress of the Work and Contractor's compliance with the approved Progress Schedule and Schedule of Submittals.
8. Completion:
 - a. Verify that all items on final list of items requiring completion or correction have been completed or corrected and make recommendations to Engineer concerning acceptance.
9. Exceptions:
 - a. Resident Project Representative:
 - 1) Shall not authorize any deviation from the Contract Documents or approve any substitute materials or equipment.
 - 2) Shall not approve or accept any portion of the completed Work.
 - 3) Shall not undertake any of the responsibilities of Contractor, Subcontractors or Contractor's superintendent, or expedite the Work.

- 4) Shall not advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract Documents.
- 5) Shall not advise on or issue directions as to safety precautions and programs in connection with the Work.
- 6) Shall not advise on or issue directions regarding Contractor's failure to comply with Laws and Regulations applicable to the furnishing or performance of the Work.

9.04 CLARIFICATIONS AND INTERPRETATIONS

- A. Engineer will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents as Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.05 AUTHORIZED VARIATIONS IN WORK - FIELD ORDER

- A. Engineer may authorize minor adjustments in the Work to avoid obstructions or interferences which do not involve an adjustment in the Contract Price or the Contract Time, and which are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and shall be binding on Owner, and also on Contractor who shall perform the change promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a request for a Change Proposal may be made therefore as provided in paragraph 10.06 or a Claim may be submitted as set forth in paragraph 11.01.

9.06 REJECTING DEFECTIVE WORK

- A. Engineer will have authority to disapprove or reject completed portions of the Work which Engineer believes to be defective and will also have authority to require special inspection or testing of the Work as provided in paragraph 13.04, whether or not the Work is fabricated, installed or completed.

9.07 SHOP DRAWINGS, CHANGE ORDERS, AND PAYMENTS

- A. Engineer's responsibility for Shop Drawings and samples are set forth in paragraphs 6.19 through 6.21 inclusive.
- B. Engineer's responsibilities as to Change Orders are set forth in Articles 10, 11, and 12.
- C. Engineer's responsibilities in respect of Applications for Payment are set forth in Article 14.

9.08 DETERMINATIONS FOR UNIT PRICE WORK

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review Engineer's preliminary determinations with Contractor 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 paragraph 10.06.

9.09 DECISIONS ON DISAGREEMENTS, CLAIMS

- A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work performed thereunder. Claims, disputes and other matters relating to the acceptability of the Work, or the interpretation of the requirements of the Contract Documents pertaining to the execution and progress of the Work, shall be referred initially to Engineer in writing with a request for a formal decision in accordance with this paragraph 9.09.

- B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them to an adjustment in the Contract Price, or Contract Times, or both, a Claim may be made under paragraph 11.01.
- C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of paragraph 11.01.
- D. In this capacity Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.10 LIMITATIONS ON ENGINEERS RESPONSIBILITIES

- A. Neither Engineer's authority to act under this Article 9 or elsewhere in the Contract Documents, nor any decision made by Engineer in good faith either to exercise or not exercise such authority, shall give rise to any duty or responsibility of Engineer to Owner or Contractor, any Subcontractor, any manufacturer, fabricator, Supplier, distributor, surety, or any other person, 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 furnishing or performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents. These limitations on authority and responsibility shall also apply to Engineer's Consultant's, Resident Project Representative and assistants.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer will not be responsible to Contractor or any Subcontractor, or Supplier, or to their agents or employees for injuries, damages, claims, losses, or expenses (including attorney's fees) of whatsoever kind resulting from or caused by any act or omission of Engineer in preparation for, arising from, relating to, or concerning the Project. Such acts or omissions include, but are not limited to, Engineer's negligence, tortuous conduct, errors, omissions, strict liability, breach of contract, or breach of warranty. Engineer makes no representations to Contractor, Subcontractors, Suppliers or their agents or employees regarding or respecting any work performed by Engineer in preparation for, arising from, relating to, or concerning the Project.
- E. Neither Contractor, its agents or employees, nor any Subcontractors or Suppliers or their agents or employees, are intended beneficiaries of Engineer's agreement with Owner, nor are such parties intended beneficiaries of Engineer's duties or responsibilities arising therefrom. Engineer disclaims all duties to Contractor, Subcontractors, Suppliers or their agents or employees arising from, relating to, or concerning Engineer's involvement in the Project. Owner and Contractor further agree to notify all Contractor's, Subcontractors or Suppliers of this disclaimer of Engineer's liability and require them to abide by this disclaimer.

ARTICLE 10 AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

10.01 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 Engineer. Such an amendment shall be set forth in a Change Order.
- 2. Work Change Directives:
 - a. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including paragraph 10.04 regarding change of Contract Price.
 - b. 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 issuance of the Work Change Directive.
 - c. 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:
 - a. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and Contractor, which shall perform the Work involved promptly.
 - b. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

10.02 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.
- B. 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 10.02 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.

10.03 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 6.18 or in the case of uncovering Work as provided in paragraph 13.03.

10.04 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 10.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of paragraph 11.01.
- 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 12.03); 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 10.04.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 12.01) plus a Contractor's fee for overhead and profit (determined as provided in paragraph 10.04.C).
- C. Contractor's Fee: When applicable, 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 paragraph 12.01.B.1 and 12.01.B.2, Contractor's fee shall be 15 percent;
 - b. for costs incurred under paragraph 12.01.B.3, 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 10.04.C.2.a and 10.04.C.2.b is that Contractor's fee shall be based on:
 - 1) a fee of 15 percent of the costs incurred under paragraphs 12.01.B.1 and 12.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and
 - 2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor;
 - 3) 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 12.01.B.4, 12.01.B.5, and 12.01.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 5 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 10.04.C.2.a through 10.04.C.2.e, inclusive.

10.05 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 10.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of paragraph 11.01.
- B. An adjustment of the Contract Times shall be subject to the limitations set forth in paragraph 12.04, concerning delays in Contractor's progress.

10.06 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 seeking 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. Each Change Proposal will address only 1 issue, or a set of closely related issues.
 - 1. Procedures: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 5 days) after the start of the event giving rise thereto, or after such initial decision. Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any) to 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
 - 2. Change Proposal and consider any comments or response from Owner regarding the Change Proposal.
 - 3. Engineer's Action: Engineer will review each Change Proposal and, within 30 days after receipt of 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 paragraph 11.01.
 - 4. 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 paragraph 11.01.
- 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 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 paragraph 11.01.

10.07 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 10.02,
 - b. required because of Owner's acceptance of defective Work under paragraph 13.08 or Owner's correction of defective Work under paragraph 13.09, 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 10.06, or Article 16.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this paragraph 10.07, it shall be deemed to be of full force and effect, as if fully executed.

10.08 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 11 CLAIMS

11.01 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 10 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 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 16 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 16 for 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 12 COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

12.01 COST OF 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 12.01 are used 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 12.01.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. Costs 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 12.01.
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. 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.
 - b. 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.
 - 1) The rental rate established for each piece of Contractor owned equipment, including appurtenances and attachments to the equipment, used will be determined by use of the Rental Rate Blue Book for Construction Equipment, Volume 1, 2 or 3, as applicable; the edition which is current at the time the Work was started will apply. The established rental rate will be equal to the "Monthly" rate divided by 176; modified by the rate adjustment factor and the applicable map adjustment factor, plus the "Estimated Operating Costs per Hour."
 - 2) For equipment not listed in the Rental Rate Blue Book, Volume 1, 2 or 3, the rental rate will be determined by using the rate listed for a similar piece of equipment or by proportioning a rate listed so that the capacity, size, horsepower, and age are properly considered.
 - 3) For equipment for which there are no comparables in the Rental Rate Blue Book, Volume 1, 2 or 3, the monthly rate shall be reasonable, but not more than 5 percent of the current list price, or invoice, of the equipment. The base hourly rate shall then be determined by dividing the monthly rate by 176 to which 20 percent will be added to the sum which will account for adjustments and operating costs.

- c. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by laws and regulations.
 - d. 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.
 - e. 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 5.03), 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
 - f. The cost of utilities, fuel, and sanitary facilities at the Site.
 - g. 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 12.01.B.1 or specifically covered by paragraph 12.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by 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 12.01.B.
- D. Contractor's Fee: 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 10.04.C.
- E. Documentation: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 12, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer on a daily basis, an itemized cost breakdown together with supporting data.

12.02 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 of 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.

12.03 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 Proposal.
- 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 Engineer's preliminary determinations with Contractor 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 12.03.E.
- E. Within 30 days of Engineer's written decision under the preceding paragraph 12.03.D, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking and 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 estimate quantity of such item indicated in the Proposal (in no event will any change in quantities of less than 25% be considered a material or significant change from the estimated quantities); and
 - 2. there is no corresponding adjustment with respect to any other item of Work.

12.04 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 request an equitable adjustment in the Contract Times and Contract Price. However, Contractor's entitlement to an adjustment of the Contract Times or Contract Price is expressly 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 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 only the following:
1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 2. acts or failures to act of utility owners (other than those performing other works at or adjacent to the Site by arrangement with Owner, as specified in paragraph 7.01); and
 3. acts of war or terrorism.
- D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
 2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
 3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 10.
- E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
1. The circumstances that form the basis for the requested adjustment;
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
 5. The impact on Contract Price, in accordance with the provisions of paragraph 10.04.
- F. Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised Progress Schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.
- G. 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 paragraphs 4.03 and 4.06.
- H. Paragraph 7.01 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.

- I. Contractor shall not be entitled to any 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.
- J. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 5 days of the commencement of the delaying, disrupting, or interfering event.
- K. Where Contractor is prevented from completing any part of the Work within the Contract Time (or Milestones) due to delay beyond the control of both Owner and Contractor, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be Contractor's sole and exclusive remedy for such delay. In no event shall Owner or Engineer be liable to Contractor, any Subcontractor, any Supplier, or any other person or organization, or to any surety or employee or any agent of them, for 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 resulting from:
 - 1. delays caused by or within the control of Contractor (or Subcontractor or Supplier);
 - 2. delays beyond the control of both Owner and Contractor, including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, or acts of neglect by utility owners or other contractors performing other work;
- L. Nor shall Owner or Engineer or each of them 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.
- M. Nothing in this paragraph 12.04 bars a change in Contract Price to compensate Contractor due to delay, interference, or disruption directly attributable to actions or inactions of Owner or anyone for whom Owner is responsible. Except for an adjustment to the Contract Times and Contract Price, Contractor shall not be entitled to and hereby waives any and all damages that it may suffer by reason of such delay or for any Act of God, including but not limited lost profits, overhead, and other consequential damages.

ARTICLE 13 TESTS AND INSPECTION; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 ACCESS TO WORK

- A. Owner, Engineer and Engineer's representatives, other representatives of Owner, testing agencies and governmental agencies with jurisdictional interests will have access to the Work at reasonable times for their observation, inspection and testing. Contractor shall provide proper and safe conditions for such access and advise Owner and Engineer of Contractor's Site safety procedures and programs so that Owner and Engineer may comply therewith as applicable.

13.02 TESTS AND INSPECTIONS

- A. Contractor shall give Engineer and testing agency at least 24-hour notice, unless otherwise specified, of readiness of the Work for all required inspections, tests or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. If any Law and Regulation, code, or order of any public body having jurisdiction requires any Work or part thereof to specifically be inspected, tested or approved, Contractor shall assume full responsibility therefor, pay all costs in connection therewith and furnish Engineer the required certificates of inspection, testing or approval.
- C. Contractor shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with Owner's or Engineer's acceptance of a manufacturer, fabricator, Supplier or distributor of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

- D. The cost of all other inspections, tests and approvals required by the Contract Documents shall be paid by Owner unless otherwise specified.
- E. All inspections, tests or approvals other than those required by law, ordinance, rule, regulation, code or order of any public body having jurisdiction shall be performed by organizations acceptable to Owner and Contractor or by Engineer if so specified.
- F. Cost of materials to be used in inspection and transportation costs shall be paid for by Contractor.
- G. Neither observations by Engineer nor inspections, tests or approvals by others shall relieve Contractor from his obligations to perform the Work in accordance with the Contract Documents.

13.03 UNCOVERING WORK

- A. If any Work that is to be tested, inspected or approved is covered without written concurrence of Engineer, or contrary to the written request of Engineer, it shall, if requested by Engineer, be uncovered by Contractor for Engineer's observation. Such uncovering shall be at Contractor's expense unless Contractor has given Engineer timely written notice of his intention to cover such Work and Engineer has not acted with reasonable promptness in response to such notice.
- B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, 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, furnishing all necessary labor, material, and equipment. Except as otherwise specified in paragraph 13.04, the cost of Work shall be paid for as follows:
 - 1. If it is found that such Work is defective, Contractor shall bear all the expenses of such uncovering, exposure, observation, inspection and testing, and of satisfactory reconstruction, (including, but not limited to, fees and charges of engineers, architects, attorneys, and other professionals) and an appropriate deductive Change Order shall be issued. If the parties are unable to agree as to the amount or extent of any change in Contract Price or Contract Time, Owner may make a Claim as provided in paragraph 11.01.
 - 2. If, however, such Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Time or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction. If the parties are unable to agree as to the amount or extent of any change in Contract Price or Contract Time, Contractor may make a Claim as provided in paragraph 11.01.

13.04 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.

13.05 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 furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, 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, Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 CORRECTION OR REMOVAL OF DEFECTIVE WORK

- A. If required by Engineer or Owner, Contractor shall promptly either correct all defective Work, whether or not fabricated, installed or completed, or if the Work has been rejected by Engineer, remove it from the Site and replace it with non-defective Work. Contractor shall pay all claims, costs, losses, damages and expenses caused by or resulting from such correction or removal (including, but not limited to all costs of repair or replacement of work of others) and shall take no action that would void or otherwise impair Owner's special warranty or guarantee, if any, on such Work.

13.07 GUARANTEE PERIOD

- A. If within 1 year after the date of Substantial Completion (or such longer period of time as may be prescribed by Laws or Regulations or 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, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. repair defective land or areas;
 - 2. correct such defective Work;
 - 3. if the defective Work has been rejected by Owner, remove it from the Site and replace it with Work that is not defective, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work or the work of others or other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or the rejected Work removed and replaced, and all claims, costs, losses, damages and expenses caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement or work of others) shall be paid by Contractor.
- C. Repair or replacements made under the guarantee shall bear an additional 1 year guarantee dated from the acceptance of repair or replacement.

13.08 ACCEPTANCE OF DEFECTIVE WORK

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, also Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, damages and expenses attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness). In such case, if acceptance occurs prior to Engineer's recommendation of final payment, a Change Order shall be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate reduction in the Contract Price. If the acceptance occurs after such recommendation, an appropriate amount shall be paid by Contractor to Owner.

13.09 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 in accordance with paragraph 13.06, or if Contractor fails to perform the Work in accordance with the Contract Documents (including any requirements of the Progress Schedule), Owner may, after 48 hours' written notice to Contractor and his Surety without prejudice to any other remedy he may have, correct and remedy any such deficiency.
- B. In exercising his rights and remedies under this paragraph 13.09, Owner shall proceed expeditiously. To the extent necessary to complete corrective and 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, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site 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's consultants such access to the Site as may be necessary to enable Owner to exercise his rights and remedies under this paragraph 13.09.

- C. All claims, costs, losses, damages and expenses incurred or sustained by Owner in exercising such rights and remedies shall be charged against Contractor and a Change Order shall be issued incorporating the necessary revisions in the Contract Documents with respect to the Work. Owner shall be entitled to an appropriate reduction in the Contract Price equivalent to such claims, costs, losses, damages and expenses including 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 Time because of any delay in performance of the Work attributable to the exercise by Owner of Owner's rights under this Article 13.

ARTICLE 14 PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 SCHEDULES

- A. At least 10 days prior to submitting the first Application for Payment, Contractor shall submit to Engineer a final Schedule of Submittals, and, where applicable, a Schedule of Values for the Work. These schedules shall be satisfactory in form and substance to Engineer as provided in Article 2.
- B. The Schedule of Values shall include quantities and unit prices aggregating the Contract Price and shall subdivide the Work into component parts. Each unit cost so established shall include its proportionate share of Contractor's general operating charges such as profit, overhead, supervision, insurance, bond premiums, interest, equipment cost, depreciation and rental, contingencies, expendable tools, equipment and supplies. The total cost of the items and quantities Contractor lists in the Schedule of Values shall equal the total Contract Price established in the Proposal.
- C. The Schedule of Values shall include a complete set of detailed work sheets on bid take off and bid summary covering estimated general conditions expense (field overhead), general overhead, profit mark ups and revisions leading to the final bid amount.
- D. When the Schedule of Values is approved by Engineer, it shall become part of the Agreement and shall be used as the basis for Contractor progress payments.
- E. Progress payments based upon Unit Price Work will be based upon the number of units completed.

14.02 APPLICATION FOR PROGRESS PAYMENT

- A. At least 20 days before each Application for Payment falls due (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment, Contractor's Declaration, Payment Schedule, and updated Progress Schedules indicating the anticipated completion dates of the various stages of the Work and estimated payments during the next 3 months. Contractor's Application for Payment shall be filled out on the form provided in the Contract Documents and signed by Contractor covering the Work completed as of the date of the Application for Payment and accompanied by such supporting documentation as is required by the Contract Documents and as Engineer or Owner may reasonably require. The Payment Schedule shall be on the form provided in the Contract Documents or in a format acceptable to Engineer or Owner. On the second and all subsequent payments, partial Waivers of Lien and Sworn Statement shall be required for all Work completed and paid for on previous certificates.
- B. 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 such data, satisfactory to Owner, as will establish Owner's title to the material and equipment and protect Owner's interest therein, including applicable insurance. A receipted vendor's invoice showing the quantities of materials and the amounts paid will be required and shall accompany the Application for Payment.

- C. Retainage with respect to progress payments will be in accordance with paragraph 14.03, and it will be retained until after completion of the entire Work and its final acceptance. When the amount to be retained is reduced to less than 10 percent, Contractor shall file with Owner the written consent of the Surety to such reduction and shall furnish an affidavit that all Contractor's indebtedness by reason of the Contract has been paid.

14.03 RETAINAGE

- A. On Contracts with a dollar value of \$30,000 and greater or on Contracts that provide for more than 3 progress payments, progress payments and retainage shall be governed by the provisions of any statutes, rules or regulations regarding retention and these are incorporated herein by reference and made a part of this Contract.
- B. If there are no statutes, rules, or regulations applicable to retention, retainage shall be 10%, or such an amount as Owner deems necessary.

14.04 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

- A. Engineer will, within 10 days after receipt of each Contractor's Application for Payment and Payment Schedule, including each resubmittal, either indicate in writing a recommendation of payment and present an Engineer's Certificate for Payment to Owner, or may 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.
- B. Engineer's recommendation of any payment requested in Contractor's Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's review of the Contractor's Application for Payment and Certificate for Payment and the accompanying data and schedules, as an experienced and qualified design professional that to the best of Engineer's knowledge, information and belief;
 - 1. the Work has progressed to the point indicated;
 - 2. the quality of the Work is in accordance with the technical aspects of the Contract Documents subject to an evaluation of the Work as a functioning Project upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for any Unit Price Work under paragraph 12.03, and any qualifications stated in the recommendation; and
 - 3. 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.
- C. However, by recommending any such payment Engineer will not thereby be deemed to have represented that:
 - 1. exhaustive or continuous on-Site inspections have been made to check the quality or the quantity of the Work; or
 - 2. involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
 - 3. 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.
- D. Neither Engineer's review of Contractor's Work for the purpose of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - 1. to supervise, direct or control the Work;

2. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
 3. for the failure of Contractor to comply with Laws and Regulations applicable to the furnishing or performance of Work;
 4. for any failure of Contractor to perform or furnish Work in accordance with the Contract Documents;
 5. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price;
 6. to determine that title to any Work, materials, or equipment has passed to Owner free and clear of Liens.
- E. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make such representations as stated above to Owner. Engineer may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:
1. the Work is defective, or completed Work has been damaged requiring correction or replacement;
 2. the Contract Price has been reduced because of Change Orders;
 3. Owner has been required to correct defective Work in accordance with paragraph 1309, or has accepted defective Work in accordance with paragraph 13.08;
 4. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
 5. Engineer has actual knowledge of the occurrence of any of the events enumerated in paragraph 15.02.

14.05 PAYMENT BECOMES DUE

- A. Thirty (30) days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of paragraph 14.05.B) become due, (or only if Owner is a public agency, within 15 days after Owner receives the funds which are to be provided by a department or agency of the federal or state government, whichever is later, or in accordance with any time periods required by any applicable statute, rule or regulation) and when due will be paid by Owner to Contractor.
- B. Owner may refuse to make payment of the full amount recommended by Engineer because:
1. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries,
 2. adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
 3. 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;
 4. Contractor has failed to provide and maintain required bonds or insurance;
 5. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

6. 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;
 7. The Work is defective, requiring correction or replacement;
 8. Owner has been required to correct defective Work in accordance with paragraph 13.09, or has accepted defective Work pursuant to paragraph 13.08;
 9. The Contract Price has been reduced by Change Orders;
 10. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
 11. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
 12. 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;
 13. there are other items as set forth in the Contract Documents entitling Owner to a set off against the amount recommended; or
 14. Owner has actual knowledge of the occurrence of any of the events enumerated in paragraphs 14.04.E.1 through 14.04.E.5.
- C. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action 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, when Contractor corrects, to Owner's satisfaction, the reasons for such action. The reduction imposed shall be binding on Contractor unless Contractor duly submits a Change Proposal contesting the reduction.
- D. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by paragraph 14.05.

14.06 CONTRACTOR'S WARRANTY OF TITLE

- A. Contractor warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner at the time of payment free and clear of all Liens, claims, security interests and encumbrances (hereafter in these General Conditions referred to as "Liens").

14.07 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. Once 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 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the

preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefore. 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 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.

14.08 PARTIAL UTILIZATION

- A. Use by Owner of completed portions of the Work may be accomplished prior to Substantial Completion of all the Work subject to the following:
 - 1. Owner at any time may request Contractor in writing to permit Owner to use any part of the Work which Owner believes to be substantially complete and which may be so used without significant interference with construction of the other parts of the Work. If Contractor agrees, Contractor will certify to Owner and Engineer that said part of the Work is substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time thereafter Owner, Contractor and Engineer shall make an inspection of that part of the Work to determine its status of completion.
 - a. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving his reasons therefor.
 - b. If Engineer considers that part of the Work to be substantially complete, Engineer will execute and deliver to Owner and Contractor a certificate to that effect, fixing the date of Substantial Completion for that part of the Work, attaching thereto a punch list of items to be completed or corrected before final payment.
 - 2. Prior to issuing a certificate of Substantial Completion for that part of the Work, Engineer will deliver to Owner and Contractor a written recommendation as to the division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, maintenance, utilities and insurance for that part of the Work, which shall become binding upon Owner and Contractor at the time of issuing the definitive certificate of Substantial Completion for that part of the Work unless Owner and Contractor shall have otherwise agreed in writing and so informed Engineer.
 - 3. Owner shall have the right to exclude Contractor from any part of the Work which Engineer has so certified to be substantially complete, but Owner shall allow Contractor reasonable access to complete or correct items on the punch list.

4. In lieu of the issuance of a certificate of Substantial Completion as to part of the Work, Owner may take over operation of a facility constituting part of the Work whether or not it is Substantially Complete if such facility is functionally and separately usable; provided that prior to any such takeover, Owner and Contractor have agreed as to the division of responsibilities between Owner and Contractor for security, operation, safety, maintenance, correction period, heat, utilities and insurance with respect to such facility.

14.09 FINAL INSPECTION

- A. Upon written notice from Contractor that the Work is complete, Engineer will 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 is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.10 FINAL APPLICATION FOR PAYMENT

- A. After Contractor has completed all corrections to the satisfaction of Engineer and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked up record documents and other documents (all as required by the Contract Documents), and after Engineer has indicated that the Work is acceptable, subject to the provisions of paragraph 14.13, Contractor may make application for final payment following the procedure for progress payments.
- B. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents and such other data and schedules as Engineer may reasonably require, consent of Surety, if any, to final payment, together with complete and legally effective releases or waivers, satisfactory to Owner, of all Liens arising out of or filed in connection with the Work.
- C. In lieu of the releases or waivers of Lien, if approved by Owner, Contractor may furnish receipts or releases in full; an affidavit of Contractor that the releases and receipts include all labor, services, material and equipment for which a Lien could be filed, and that all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or his property might in any way be responsible, have been paid or otherwise satisfied.
- D. If any Subcontractor, manufacturer, fabricator, Supplier or distributor fails to furnish a release or receipt in full, Contractor may furnish a Bond or other collateral satisfactory to Owner to indemnify Owner against any Claim or Lien.

14.11 FINAL PAYMENT AND ACCEPTANCE

- A. 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 (all as required by the Contract Documents), Engineer is satisfied that to the best of Engineer's knowledge, information and belief as a design professional that the Work has been completed and Contractor has fulfilled all of his obligations under the Contract Documents, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's Certificate for Payment and present the application to Owner for payment. At that time Engineer will give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of paragraph 14.13.
- B. Otherwise, Engineer will return the Application 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.
- C. If the Application and accompanying documentation are appropriate as to form and substance, Owner shall, within 45 days (or within the time period required by any applicable statute, rule or regulation) after receipt thereof pay Contractor the amount recommended by Engineer less any amounts of Owner claimed set-offs allowed under the Contract Documents, including but not limited to any applicable liquidated damages as determined by Owner. If Owner rejects the Application, Owner shall do so in writing stating the appropriate sections of the Contract

Documents upon which the rejection is based. Contractor may take the necessary remedial actions and resubmit the Application.

14.12 FINAL COMPLETION DELAYED

- A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment and recommendation of Engineer, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.01, the written consent of the Surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.13 WAIVER OF CLAIMS

- A. The making and acceptance of final payment shall constitute:
 - 1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to paragraph 14.09, or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; and shall not constitute a waiver by Owner of any rights in respect of Contractor's existing or continuing obligations under the Contract Documents; and,
 - 2. a waiver of all Claims by Contractor against Owner other than those previously made in writing and still pending in accordance with Article 16.

14.14 LATE PAYMENTS

- A. All monies not paid when due hereunder, except monies involving Federal and/or State Loans, Grants, or other sources which are delinquent because of no fault of Owner, shall bear interest at the maximum rate allowed by law at the time and place of the Project.

ARTICLE 15 SUSPENSION OF WORK AND TERMINATION

15.01 OWNER MAY SUSPEND WORK

- A. Owner may, at any time and without cause, suspend the Work or any portion thereof for a period as Owner may deem necessary by notice in writing to Contractor and Engineer. If it should become necessary to stop work for an indefinite period, Contractor shall store all materials in such manner that they will not become an obstruction, nor become damaged in any way, and Contractor shall take every precaution to prevent damage or deterioration of the Work performed; provide suitable drainage by opening ditches and drains, and erect temporary structures where necessary. Contractor may request an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if he makes a Claim therefor as provided in paragraph 11.01.

15.02 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 commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if Contractor takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time;
 - 2. a petition is filed against Contractor under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent

or similar relief against Contractor under any other federal or state law in effect at the time relating to bankruptcy or insolvency;

3. Contractor makes a general assignment for the benefit of creditors;
 4. a trustee, receiver, custodian or agent of Contractor is appointed under applicable law or under contract, whose appointment or authority to take charge of property of Contractor is for the purpose of enforcing a Lien against such property or for the purpose of general administration of such property for the benefit of Contractor's creditors;
 5. Contractor admits in writing an inability to pay its debts generally as they become due;
 6. Contractor persistently fails 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 established under paragraph 2.05 as revised from time to time);
 7. Contractor disregards Laws and Regulations of any public body having jurisdiction;
 8. Contractor disregards the authority of Engineer or Owner; or,
 9. Contractor otherwise violates any provisions of the Contract Documents.
- B. Owner may, after giving Contractor (and the Surety, if there be one) 7 days' written notice, and to the extent permitted by Laws and Regulations, terminate the services of Contractor, exclude Contractor from the Site, take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the site and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion), incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, finish the Work as Owner may deem expedient, and/or enforce the rights available to Owner under any applicable Performance Bond.
- C. In such case, Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, damages and expenses sustained by Owner arising out of or resulting from completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, damages and expenses exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, damages and expenses incurred by Owner will be reviewed as to reasonableness by Engineer and when so approved, incorporated in a Change Order, but when exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.
- D. Where Contractor's services have been so terminated by Owner, the termination shall not affect any rights or remedies of Owner against Contractor or its Surety then existing or which may thereafter accrue. Any retention or payment of monies due Contractor by Owner will not release Contractor from liability.

15.03 TERMINATION FOR CONVENIENCE

- A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy, elect to terminate the Agreement. In such case, Contractor shall be paid (without duplication of any items):
1. for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination;
 2. for actual 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; and
 3. for reasonable expenses directly attributable to protecting work as a result of termination.

- B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.
- C. Upon such termination, Contractor shall:
 - 1. Immediately discontinue Work on the date and to the extent specified in the notice except to the extent necessary to protect Work in place;
 - 2. Place no further orders for materials, services, or facilities, other than as may be necessary or required for completion of such portion of Work under the Contract that is not terminated;
 - 3. Promptly make every reasonable effort to obtain cancellation upon terms reasonably satisfactory to Owner of all purchase orders and subcontracts to the extent they relate to the performance of Work terminated or assign to Owner those orders and subcontracts and revoke agreements specified in such notice;
 - 4. Reasonably assist Owner, as specifically requested in writing, in the maintenance, protection and disposition of property acquired by Owner under the Contract Documents, as may be necessary;
 - 5. Complete performance of any Work which is not terminated; and
 - 6. Deliver to Owner an affidavit regarding the identity of potential unpaid Subcontractors or Suppliers and the amounts due to each.

15.04 CONTRACTOR MAY STOP WORK OR TERMINATE

- A. If Owner has failed to pay Contractor any sum finally determined to be due in accordance with the time limits specified in paragraph 14.05, Contractor may upon 7 days' written notice to Owner and Engineer, stop the Work until payment of all amounts then due.
- B. If through no act or fault of Contractor, the Work is suspended for a period of more than 90 days by Owner, or under an order of court or other public authority, then Contractor may, upon 7 days written notice to Owner and Engineer and provided Owner or Engineer does not remedy such suspension or failure within that time, terminate the Agreement and recover from Owner payment on the same terms as provided in paragraph 15.03.
- C. The provisions of this paragraph 15.04 shall not relieve Contractor of his obligations under paragraph 6.22 to carry on the Work in accordance with the Progress Schedule and without delay during disputes and disagreements with Owner.

ARTICLE 16 FINAL RESOLUTION OF DISPUTES

16.01 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, the following dispute resolution process shall be followed:

- a. The parties shall submit the dispute to mediation under the mediation procedures outlined in the Construction Industry Arbitration Rules and Mediation Procedures of the American Arbitration Rules.
- b. If the dispute is not resolved by mediation, the parties shall proceed to resolve the dispute by arbitration in accordance with the Construction Industry Arbitration Rules and Mediation Procedures of the American Arbitration Association. The decision of the arbitrator(s) shall be final and binding and is enforceable in a court of competent jurisdiction.

ARTICLE 17 MISCELLANEOUS

17.01 GIVING NOTICE

- A. Whenever any provision of the Contract Documents requires the giving of written notice to Owner, Engineer, or Contractor, it shall be deemed to have been validly given only if delivered:
 1. in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended;
 2. by registered or certified mail postage prepaid to, the last business address known to the giver of the notice;
 3. or delivered in person to such person by a commercial courier service or otherwise to the recipient's place of business; or
 4. by secure file transfer with receipt documentation or other document control software.

17.02 COMPUTATION OF TIME

- A. When any period of time is referred to in the Contract Documents by days, it shall 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 shall be omitted from the computation.

17.03 GENERAL

- 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 shall not 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 Law or Regulation, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this paragraph shall 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.
- B. All representations, warranties and guarantees made in the Contract Documents shall survive final payment and termination or completion of this Agreement.

17.04 PROFESSIONAL FEES AND COURT COSTS INCLUDED

- A. Whenever reference is made to "claims, costs, losses, damages and expenses," it shall include in each case, but not be limited to, all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs.

17.05 NONDISCRIMINATION OF EMPLOYMENT

- A. Contractor shall covenant and agree not to discriminate against any employee or applicant for employment, to be employed in the performance of this Contract, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, sex, age, religion, national origin or ancestry, height, weight, or marital status, or any other classification protected by law, and to require a similar covenant on the part of any Subcontractor employed in the performance of the Contract.

17.06 POST COMPLETION DATE ENGINEERING AND INSPECTION COSTS

- A. All engineering and inspection costs incurred after the specified completion date shall be paid by Contractor to Owner prior to final payment authorization. However, Contractor shall not be charged with any post completion date engineering and inspection costs when the delay in completion of the Work is due to the following and Contractor has promptly given written notice of such delay to Owner or Engineer:
 - 1. to any preference, priority or allocation order duly issued by Owner;
 - 2. to unforeseeable causes beyond the control and without the fault or negligence of Contractor, including but not restricted to, acts of God, or of the public enemy, acts of Owner, acts of another contractor in the performance of a Contract with Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; and,
 - 3. to any delays of Subcontractors or Suppliers occasioned by any of the causes specified in this Article.
- B. Charges after the specified completion date shall be made at such times and in such amounts as Engineer shall invoice Owner, provided, however said charges shall be in accordance with Engineer's current rate schedule at the time the costs are incurred. Engineering and inspection costs so incurred shall be deducted from Contractor's progress payments.

17.07 WAIVER OF CONSEQUENTIAL DAMAGES

- A. Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract or the Work. This mutual waiver includes but is not limited to:
 - 1. damages incurred by Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
 - 2. damages incurred by Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit in connection with any other project or anticipated project.
- B. This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination or default. Nothing contained in this Section shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents. Contractor also waives any Claim for consequential damages against Engineer where such Claims arise out of or relate in any way to the Project or the Contract Documents.

17.08 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.

17.09 CONTROLLING LAW

- A. This Contract is to be governed by the Law of the state in which the Project is located.

17.10 HEADINGS

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

END OF SECTION

SECTION 00 73 00 SUPPLEMENTARY CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

- A. These Supplementary Conditions amend and supplement Section 00 72 00 - General Conditions and other provisions of Contract Documents as indicated below. Provisions that are not so amended or supplemented remain in full force and effect.
- B. The terms used in these Supplementary Conditions that are defined and have the meanings assigned to them in Section 00 72 00.

1.02 MODIFICATIONS TO GENERAL CONDITIONS

A. SGC-1.01 Defined Terms

- 1. The definition for "Substantial Completion" in shall be revised as follows:

Substantial Completion -- The Work (or a specified part thereof) has progressed to the point where, in the opinion of the Engineer as evidenced by the Certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it was intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by the Engineer's written recommendation of final payment in accordance with Article 14.11 of Section 00 72 00 - General Conditions. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

B. SGC-5.03.D Additional Insured

- 1. Add the following language at the end of Article 5.03.A.4 of the Section 00 72 00 - General Conditions:

Additional named insured on Owner's and Contractor's Protective Policy shall include: Wade Trim and Hubbell, Roth & Clark.

C. SGC-5.04 Limits of Liability

- 1. The required limits of liability for insurance coverages requested in Article 5.03 of Section 00 72 00 - General Conditions shall be not less than the following:

SGC-5.04.A Worker's Compensation

Coverage A – Compensation: Statutory

Coverage B – Employer's Liability

Each Accident: \$100,000

Disease – Policy Limit: \$100,000

Disease – Each Employee: \$100,000

SGC-5.04.B Comprehensive General Liability

General Aggregate: \$1,000,000

Products – Com/Ops Aggregate: \$1,000,000

Personal and Advertising Injury: \$500,000

Each Occurrence: \$500,000

Fire Damage (any one fire): \$50,000

Medical Expense (any one person): \$5,000

SGC-5.04.C Comprehensive Automobile Liability

Bodily Injury: \$500,000

Property Damage: \$200,000

or combined single limit: \$1,000,000

SGC-5.04.D Owner's Protective - Coverage shall be Occurrence Form

General Aggregate:\$1,000,000 \$1,000,000

Each Occurrence: \$1,000,000

SGC-5.04.E Builder's Risk-Installation Floater

Cost to Replace at Time of Loss

SGC-5.04.F Umbrella or Excess Liability: \$2,000,000

D. SGC- 12.04 Lump Sum Work

1. Add the following new paragraph after Article 12.03 of Section 00 72 00 - General Conditions, which is to read as follows:

12.04 LUMP SUM WORK

- a. When additional work or deletion of work, which is covered by a lump sum item, is required due to a modification, not a normal overrun or underrun in estimated quantities, payment or credit for the work will be based upon apparent unit prices which will be derived by dividing the lump sum price by the estimated plan quantities.
- b. Renumber subsequent paragraphs accordingly.

E. SGC-18 Liquidated Damages

1. Liquidated damages, if applicable, are referenced in the Proposal and Agreement. The requirements for liquidated damages should be included herein.

ARTICLE 18 LIQUIDATED DAMAGES

- a. If the Contractor shall fail to Substantially Complete the Work within the Contract Time, or extension of time granted by the Owner, then the Contractor will pay to the Owner the amount for liquidated damages as specified in the Agreement for each calendar day that the Contractor shall be in default after the time stipulated in the Contract Documents. The liquidated damages charged shall be deducted from the Contractor's progress payments.
- b. Contractor shall not be charged with liquidated damages or any excess cost when the delay in Substantial Completion of the Work is due to the following and the Contractor has given written notice of such delay within seven (7) calendar days to Owner or Engineer.
- c. To any preference, priority or allocation order duly issued by the Owner.
- d. To unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not restricted to, acts of God, or of the public enemy, acts of the Owner, acts of another Contractor in the performance of a Contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; and
- e. To any delays of subcontractors occasioned by any of the causes specified in Items A and B of this Article.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 00 SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. This Project includes replacement of the existing final clarifier influent control valves and flowmeters and RAS control valves and flowmeters for the Battery B Secondary Clarifiers and ancillary equipment.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 50 00 - Temporary Facilities and Controls

1.03 WORK BY OTHERS

- A. There is no other work in the Project area, known to the Owner, which would affect this Contract.

1.04 COORDINATION

- A. It shall be the responsibility of the Contractor to coordinate his operations and those of his subcontractors in such a manner so as to avoid interference and delays in the areas of common construction activities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 12 13 WORK SEQUENCE

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes a suggested sequence of construction for the Work specified in the Contract Documents. Contractor is not obligated to follow the sequence described herein; Contractor is responsible for means and methods in order to complete the specified Work.

1.02 PROJECT CONSTRAINTS

- A. All four secondary clarifiers will be out of service during the construction period. No construction shall start until the new valves and materials are delivered to the site except for work that does not impact operation of the existing system.
- B. Contractor shall be responsible to pump out and dispose of any areas or pipes that may have liquid in them prior to commencing work on the project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 21 00 ALLOWANCES

PART 1 GENERAL

1.01 GENERAL

- A. Contractor shall include Allowance(s) listed in the Bid Proposal that shall cover work, manufactured equipment or services that will be provided either by Contractor or by others who may be selected by Owner.
- B. Work performed under Allowances shall be subject to Owner approval and under special terms described herein. Contractor shall coordinate and cause the work covered by these Allowances.
- C. It is understood that Contractor has included in the Contract Price 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.

1.02 REQUIREMENTS

- A. Allowances shall be administered in accordance with the provisions of the General Conditions of the Contract. Contractor shall be required to coordinate this work with the agency involved and pay all costs the agency may charge in connection with this work.
- B. Thereafter, if the actual price for this work is more or less than the allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made on the basis of the actual invoice price without additional charge or markups for overhead, insurances, bonds, or any other incidental expenses.
- C. Contractor shall be responsible for all coordination with the agency involved and for the timely completion of the Work to fit his schedule. Contractor shall not be allowed any additional compensation for the failure of the agency involved to meet any schedule.

1.03 RELATED REQUIREMENTS

- A. The requirements of Section 00 72 00 and all Division 01 sections shall also apply to this work.

1.04 DEFINITIONS

- A. Lump Sum Allowance: A monetary sum that includes, as part of the Contract Price, the associated costs and requirements to complete the specified Allowance.
- B. Owner-Controlled Change Allowance: A monetary sum that is, as part of the Contract Price, the sole use of Owner to cover unanticipated costs and will be used only under the direction of Owner.

1.05 SUBMITTALS

- A. Submit invoices or delivery slips to indicate actual quantities of materials delivered to the Site for use in fulfillment of each Allowance.

1.06 INSTRUCTIONS

- A. At the earliest feasible date after Contract Award, Contractor shall advise Engineer of the date when the final selection and purchase of each product or system described by an Allowance must be completed in order to avoid delay in performance of the work.
- B. When requested by Engineer, Contractor shall obtain Bids for each Allowance for use in making final selections; include recommendations that are relevant to performance of the Work.
- C. Contractor shall purchase products and systems as selected by Engineer from the designated Supplier.

- D. Allowances shall be used only as directed for Owner's purposes, and only by Change Orders which designate amounts to be charged to the Allowance.
- E. If the actual price for the specified Allowance is more or less than the stated Allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made in accordance with the General Conditions.
- F. At Project closeout, any amounts remaining in Allowances will be credited to Owner by Change Order.

1.07 SPECIFIC ALLOWANCES

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

SECTION 01 31 19 PROJECT MEETINGS

PART 1 GENERAL

1.01 PRECONSTRUCTION MEETING

- A. Prior to the delivery of materials or the start of any construction, the Contractor shall request a Preconstruction Meeting from the Engineer. A minimum three (3) working days' notification to meeting participants shall be required.
- B. Schedule:
 - 1. Engineer will establish the meeting place, time and date, distribute agenda, notify participants, and administer the meeting. Contractor shall notify major Subcontractors.
- C. Attendance:
 - 1. Owner
 - 2. Engineer
 - 3. Contractor
 - 4. Major Subcontractors
 - 5. Utility Companies
 - 6. Safety Representatives
 - 7. Governmental Agencies
- D. Agenda:
 - 1. Distribution by the Contractor and discussion, review and acceptance of:
 - a. List of names and telephone numbers for superintendent, foreman and other key personnel.
 - b. List of major Subcontractors and Suppliers.
 - c. Projected construction preliminary progress schedules.
 - d. Preliminary schedule of Shop Drawings and Sample submittals.
 - e. Estimated monthly payment schedule and schedule of values
 - 2. Critical Work sequencing.
 - 3. Major equipment deliveries and priorities.
 - 4. Project coordination.
 - 5. Responsibilities of Owner, Engineer, Contractor and other agencies.
 - 6. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Applications for Payment.
 - 7. Adequacy of distribution of Contract Documents.
 - 8. Procedures for maintaining Record Documents.

9. Use of premises.
 10. Construction facilities, controls and construction aids.
 11. Temporary utilities.
 12. Safety and first aid procedures.
 13. Security procedures.
 14. Housekeeping procedures.
 15. Testing
- E. Minutes:
1. Engineer will prepare and distribute copies to participants within seven (7) days of meeting. Participants shall report corrections and comments within ten (10) days of receipt of minutes.

1.02 PROGRESS MEETINGS

- A. Periodic Progress Meetings will be held as required by the progress of the Work.
- B. Schedule:
1. Engineer will establish the meeting place, time and date, distribute agenda, notify participants and administer the meeting. Contractor shall notify major Subcontractors.
- C. Attendance:
1. Engineer
 2. Contractor
 3. Subcontractor as appropriate to the agenda.
 4. Suppliers as appropriate to the agenda.
 5. Others
- D. Agenda:
1. Review minutes of previous meeting.
 2. Review of work progress since previous meeting.
 3. Review field observations, problems, conflicts.
 4. Review problems which impede Construction Schedules.
 5. Review of off-site fabrication, delivery schedules.
 6. Review corrective measures and procedures to regain projected schedule.
 7. Review revisions to Construction Schedules.
 8. Review plan progress, schedule, during succeeding Work period.
 9. Review coordination of schedules.
 10. Review submittal schedules; expedite as required.
 11. Review maintenance of quality standards.
 12. Review proposed changes for:
 - a. Effect on Construction Schedule and on completion date.
 - b. Effect on other Contracts of the Project.
 13. Other business.

E. Minutes:

1. Engineer will prepare and distribute copies to participants and the Owner within seven (7) days of meeting for review at the next meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00 SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Contractor shall submit Shop Drawings, product data, and Samples, as required by the individual Specification sections, to the Engineer for review in accordance with the provisions of Section 00 72 00 - General Conditions.

1.02 PROGRESS SCHEDULES

- A. Contractor shall submit one (1) electronic copy in PDF format of Progress Schedules indicating the starting and completion dates of the various stages of the Work and estimated payments to the Engineer.
 - 1. Proposed Progress Schedules shall be submitted to the Engineer prior to the pre-construction meeting.
 - 2. Contractor shall distribute hard copies of the Progress Schedules during the pre-construction meeting for discussion.
 - 3. Progress Schedules shall be updated by the Contractor and submitted electronically (in PDF format) to the Engineer, as a part of applications for progress payments, through completion of the Work. Failure to update Progress Schedule may be the basis for rejection of Applications for Progress Payments.

1.03 SHOP DRAWING SCHEDULE

- A. Contractor shall submit one (1) electronic copy in PDF format of the Shop Drawing Schedule indicating the individual items and submission dates to the Engineer.
 - 1. A preliminary Shop Drawing Schedule in accordance with the requirements in Section 00 72 00 shall be submitted by the Contractor prior to the pre-construction meeting.
 - 2. Contractor shall distribute hard copies of the Shop Drawing Schedule during the pre-construction meeting for discussion.
 - 3. A final electronic copy of the Shop Drawing Schedule (in PDF format) shall be submitted by the Contractor at least ten (10) days prior to submitting the first Application for a Payment.

1.04 SCHEDULE OF VALUES

- A. Contractor, if applicable, shall submit one (1) electronic copy in PDF format Schedule of Values of the Work to the Engineer.
 - 1. A preliminary Schedule of Values shall be submitted by the Contractor prior to the pre-construction meeting.
 - 2. Contractor shall distribute hard copies of the Schedule of Values during the pre-construction meeting for discussion.
 - 3. A final Schedule of Values (in PDF format), prepared in accordance with the Section 00 72 00 and presented in sufficient detail to serve as the basis for payments during construction, shall be submitted to the Engineer for review at least ten (10) days prior to submitting the first Application for Payment.

1.05 APPLICATIONS FOR PAYMENT

- A. Contractor shall submit one (1) electronic copy in PDF format Applications for Payment to the Engineer in accordance with the provisions of Article 14 of Section 00 72 00.
- B. Applications for Payment shall be made on forms provided by or approved by the Engineer.

1. Samples of the Contractor's Application for Payment, Payment Schedule and Engineer's Certificate for Payment forms are included in the Contract Documents and can be obtained in digital format from the Engineer.
- C. Copies of these forms, with Project specific information completed by the Engineer, will be given to the Contractor at the preconstruction meeting or, if applicable, after approval of the final Schedule of Values.
- D. Contractor shall submit a completed Payment Schedule with an executed Contractor's Application for Payment and Contractor's Declaration to the Engineer not more often than once per month.
- E. Engineer will certify payments with the use of Engineer's Certificate for Payment.

1.06 SHOP DRAWINGS

- A. Shop Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to plan sheet number, detail number if applicable, and Specification Section number, and article number.

1.07 PRODUCT DATA

- A. Product Data shall be presented in a clear and thorough manner identified the same as the Shop Drawings. Included with the information shall be performance characteristics and capacities depicting dimensions and clearances required.
- B. Manufacturer's standard schematic drawings and diagrams shall be modified to delete information which is not applicable to the Work. Manufacturer's standard information shall be supplemented to provide information specifically applicable to the Work.

1.08 SAMPLES

- A. Samples shall be of sufficient size and quantity to clearly illustrate functional characteristics of the product with integrally related parts and attachment devices depicting full range of color, texture and pattern.

1.09 SUBMISSION REQUIREMENTS

- A. Contractor shall make Submittals in accordance with the approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor. No damages will be awarded, or extension of time granted, due to the Shop Drawing and product data review process.
- B. Contractor shall submit an entire package of Shop Drawings and Product Data information for major items of Work so that the Engineer can review the package as a unit.
- C. Contractor shall submit one (1) electronic copy in PDF format of Shop Drawings and Product Data information containing the following information at a minimum:
 1. Field dimensions clearly identified as such.
 2. Relation to adjacent or critical features of the Work or materials.
 3. Applicable standards, such as ASTM or Federal Specification Numbers.
 4. Identification of deviations from Contract Documents.
 5. Identification of revisions on resubmittals.
 6. Project Title, Date of Submission, Date of Previous Submission, and Specification Section number.
- D. Contractor shall initial or sign Shop Drawings and Product Data submittals, certifying the Contractor's review and approval of Submittal per Section 00 72 00; verification of products, field measurements, field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents.

- E. Engineer shall initial or sign Shop Drawings and Product Data submittal and shall indicate the status of the Submittal, or requirements for resubmittal. Engineer shall return to the Contractor one (1) electronic copy of the Shop Drawing and/or Product Data submittal (in PDF format) for distribution or for resubmission.

1.10 ENGINEER'S REVIEW

- A. Upon receipt of any Submittal defined above, the Engineer will:
 - 1. Check each for completeness, clarity, correctness, cohesiveness, legibility, and reproducibility.
 - 2. Review each only for general conformity with the Contract Documents as specified in Section 00 72 00.
- B. After review of any Submittal, the Engineer will appropriately affix a stamp, electronic notation box or other means, signifying the Submittal as having received full consideration and review.
- C. The "status" of any such Submittal or portion thereof, as appropriate, will be evidenced by any one or more of the following notations clearly signified by a "X" or other similar mark placed in the box adjacent to the notation:
 - 1. Notations for Engineer's Review:
 - a. No Exceptions Taken
 - b. Note Markings
 - c. Comments Attached
 - d. Rejected
 - 2. Notations for Response Required by Contractor:
 - a. None
 - b. Confirm
 - c. Resubmit
- D. Notation Meanings:
 - 1. Elements marked "No Exceptions Taken" indicate that the Contractor may commence with construction, fabrication or purchase of such items.
 - 2. Elements marked "Note Markings" indicate that the Contractor may commence with construction, fabrication or purchase of such items.
 - a. Proceeds in strict accordance with the Engineer's notes and/or required corrections/deletions/additions indicated thereon;
 - b. Pending appropriate response by the Contractor as further noted.
 - 3. Elements marked "Comments Attached" indicate that further comments or explanations have been affixed to the Submittal, which may require action(s) by the Contractor as further noted.
 - 4. Elements marked "Rejected" indicate that the Contractor must make the required corrections as shown or noted and resubmit such items to the Engineer for further review.
 - 5. Elements marked "None" indicate that the Submittal requires no further action by the Contractor.
 - 6. Elements marked "Confirm" requires the Contractor to provide affirmation to the Engineer regarding comments, notes, markings, etc. made by the Engineer, and to affirm that the Contractor will comply with the comments, notes, markings, etc.

7. Elements marked "Resubmit" indicate that the Contractor may not commence with construction, fabrication or purchase of such items, and that the Contractor must resubmit items for review that comply with the Contract Documents in the event that those originally submitted do not, or with any comments, notes, markings, etc. made by the Engineer.

1.11 RESUBMISSION REQUIREMENTS

- A. Contractor shall make all corrections or changes in the Submittals required by Engineer and resubmit. Contractor shall indicate any changes which have been made other than those requested by the Engineer.

1.12 MANUFACTURER'S OPERATION AND MAINTENANCE DATA

- A. Contractor shall submit one (1) electronic copy in PDF format and one (1) bound copy of all operation and maintenance data required per the various Specification sections.
 1. Prior to 50% completion of the Project, Contractor shall have submitted one (1) acceptable copy to the Engineer for review.
- B. Final copies of the operation and maintenance data shall be bound in a suitable number of 3-inch or 4-inch, 3-ring hard cover binders. Permanently imprinted on the cover shall be the words "Manufacturer's Operation and Maintenance Data", Project title, location of the Project, and the date. A table of contents shall be provided in the front of each binder to list the various sections in the manual.
- C. The information to be provided in each section of the manual, for each piece of equipment and project component shall include, but not be limited to, detailed equipment drawings; sections cut through all of the major equipment and subassemblies; installation and operational procedures; complete wiring and piping schematics; lubrication materials and procedures; maintenance procedures; and parts lists complete enough to permit identification of parts by nomenclature, manufacturer's part number and use.
- D. At the front of each section a maintenance schedule shall be provided for each piece of equipment in the section.
 1. The schedule shall display the daily, weekly, monthly, semi-annual, annual or fraction thereof, lubrication and preventative maintenance required in order to meet warranty conditions and the manufacturer's recommendations for optimum performance and life of the unit.
 2. A common schedule format is to be developed and used for all of the sections. Photocopies or reproductions of the manufacturer's literature will not be accepted.

1.13 AUDIO/VIDEO ROUTE SURVEY

- A. When required in Section 00 42 43 - Proposal or Section 01 11 00 - Summary of Work, the Contractor shall furnish the Engineer with an "Audio/Video Route Survey" record of the existing conditions prior to the start of construction. Contractor must enlist the services of a firm having a minimum of one (1) year experience in audio/video recording of construction projects.
- B. Prior to beginning the audio/video recording, the Contractor shall review with Engineer the Project requirements to ensure that the audio/video is adequate for its intended purpose. Owner shall have the authority to designate areas for which coverage may be added or omitted. The audio/video recording shall be done prior to placement of materials or equipment on the construction area and furnished one (1) week prior to the pre-construction meeting.
- C. Format:
 1. Audio/Video route survey shall be submitted in the format(s) as specified in Section 01 11 00.
 - a. Audio/video route survey submission shall be on USB media
 - b. Format: USB – Video

- c. Video Encoding: Highest available bit rate (6-9 Megabit), 60 fields per second interlaced video
 - d. Audio Encoding: Uncompressed stereo wave or stereo Dolby Digital (256 kilobit or better)
 - e. Aspect Ratio: 4x3 (720x480 pixels)
 - f. No Macrovision or other copy protection encoding. No region code or region code 1.
- D. Complete coverage shall include all surface features located within the public right-of-way, easement areas and adjacent private properties up to building line when such properties lie within the zone of influence of construction and will be supported by appropriate audio description made simultaneously with video coverage. Such coverage shall include, but not be limited to, all existing driveways, sidewalks, curbs, ditches, roadways, landscaping, trees, culvert, headwalls, retaining walls, and buildings located within such zone of influence. Video coverage shall be clear enough to identify cracks, depressions, holes and other defects in existing surfaces.
- E. Houses and buildings shall be identified visually by house number, when visible, in such a manner that structures of the proposed system can be located by reference. In all instances, however, location shall be identified by audio or visual means at intervals not-to-exceed 100 linear feet (30 m) in the general direction of travel.
- F. When conventional wheeled vehicles are used, the distance from the camera lens to the ground shall be not less than 12 feet (3.5 m) to ensure proper perspective. The rate of speed in the general direction of travel of the conveyance used during recording shall not exceed 30 feet/minute (10 m/min). Panning rates and zoom-in, zoom-out rates shall be controlled sufficiently such that stop action during play-back will produce clarity of detail of the object viewed.
- G. Video recordings must, by electronic means, display continuously and simultaneously generated transparent digital information in the upper left hand third of the screen to include the date and time of recording, as well as the corresponding engineering stationing numbers as shown on the Contract Drawings.
- 1. The date information will contain the month, day, and year. For example, mm/dd/yy, and be placed directly below the time information.
 - 2. The time information shall consist of hours, minutes, and seconds, separated by colons. For example, hh:mm:ss.
- H. Engineering stationing numbers must be continuous, accurate and correspond to the Project stationing and must include the standard engineering symbols. For example, Station 14+84.
- I. Recording shall be done during times of good visibility. No recording shall be done during periods of visible precipitation, or when more than ten (10) percent of the ground area is covered with snow or standing water, unless otherwise authorized by the Owner.
- J. In some instances, audio/video coverage may not be suitable for recording necessary details. In such instances, the Owner may specify still photographs to provide coverage. One (1) color photograph shall be provided in accordance with this Section with a suitable description of the photograph's location.
- K. Any portion of the Audio/Video Route Survey of insufficient quality as determined by the Engineer shall be redone by the Contractor at no additional cost to the Owner.
- L. Each USB shall be properly identified with the Project Title, location, time, and date in a manner acceptable to the Owner.

1.14 PHOTOGRAPHS

- A. When required in Section 00 42 43 or Section 01 11 00, the Contractor shall furnish the Engineer with a total of 6 to 10 digital color photographs each month during construction of the

Project, unless some other number and times is specified in Section 01 11 00 - Summary of Work.

- B. Photos shall be in digital format (i.e., JPEG, TIFF, GIF, PNG or PDF) and shall have a minimum resolution of 300 dpi.
- C. The following information shall be placed on the photo itself or embedded in the digital file:
 - 1. Project Title
 - 2. Contract Number
 - 3. Description of photo's content
 - 4. Date and Time of photo
- D. Contractor shall submit photographs monthly along with the Application for Payment as described in Article 14 of Section 00 72 00.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00 QUALITY CONTROL

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Sampling of materials will be made by the Engineer in accordance with the methods designated by the Specifications. Contractor shall furnish such facilities as the Engineer may require for collecting, storing, and forwarding samples to the Laboratory. Contractor in all cases shall furnish the required samples to the Owner without charge.

1.02 TESTS OF MATERIALS

- A. Materials in the Work shall meet the requirements of the Contract Documents.
- B. Tests of materials will be made as specified herein. Engineer shall at all times have access to all materials intended for use in the Work as well as to the plants where such materials are produced. Plant inspection may be made if the quantities are sufficient to warrant such inspection and if it is to the best interest of the Owner. In any case materials may be either inspected or tested when received on the Project.
- C. Materials shall not be used until approval has been received from the Engineer. Approval of materials at the producing plant does not constitute a waiver of the Engineer's right for re-examination at the Project site.
- D. The standards for testing materials unless otherwise specified, shall be as established by the American Society for Testing and Materials (ASTM). Tests of materials will be made in accordance with the methods described or designated in the Specifications.
- E. The sampling and testing of all materials not specifically mentioned shall be done by generally accepted methods, unless otherwise specified by the Engineer.

1.03 CERTIFICATION OF MATERIALS

- A. At the request of the Engineer, the Contractor shall provide the Engineer with certification that the various materials to be used conform to the standards referred to in the Contract Documents.

1.04 SOURCE QUALITY CONTROL

- A. Testing identified in these specifications as Quality Control, which is required to establish quality of materials, equipment or fabricated items, shall be paid for by the Contractor unless otherwise noted.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 50 00 TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SITE ACCESS AND PARKING

- A. Contractor shall locate roads, drives, walks and parking facilities to provide uninterrupted access to construction offices, mobilization, Work, storage areas, and other areas required for execution of the Contract. Access drives and parking areas shall be hard surfaced unless otherwise approved by the Engineer.
- B. Contractor shall maintain driveways a minimum of 15 feet (5 meters) wide between and around combustible materials in storage and mobilization areas.
- C. Contractor shall maintain traffic areas as free as possible of excavated materials, construction equipment, products, snow, ice, and debris.
- D. Contractor shall not utilize existing parking facilities for construction personnel or for Contractor's vehicles or equipment, unless written permission from owner of parking facility is obtained.

1.02 EMERGENCY ACCESS

- A. Contractor shall at all times provide emergency access to property in the vicinity of the construction for police vehicles, fire equipment, ambulances or other emergency vehicles to protect life, health and property. Areas damaged by emergency vehicles shall be restored by the Contractor at no additional cost to the Owner.

1.03 TEMPORARY ELECTRICITY AND LIGHTING

- A. Contractor shall be responsible for and pay all costs for the installation and removal of circuit and branch wiring, with area distribution boxes located so that power and lighting is available throughout the construction by the use of construction-type power cords and shall pay all costs of electrical power used.
- B. Electrical wiring and distribution shall conform to the National Electrical Code as adopted by the State of Michigan.

1.04 TELEPHONE

- A. Contractor is required by MIOSHA regulations to provide telephone service for contacting emergency services. Such emergency telephone service shall also be available for the use of the Owner and Engineer whether or not a field office is required for the Project. Emergency phone numbers are required to be posted per MIOSHA regulations
- B. Contractor shall pay all costs for installation, maintenance and removal, and service charges for local calls to provide service for his construction site office as well as for the Engineer's field office. Toll charges for calls relating to Project business shall be at the Contractor's expense.

1.05 USE OF WATER

- A. Contractor shall acquire any and all permits, post any bonds and pay all fees required by the local agency having jurisdiction prior to using any hydrant or any other source of water. Contractor shall reimburse the local community for all water consumed during course of the Project at the current rate as set by the agency having jurisdiction.

1.06 SANITARY PROVISIONS

- A. Contractor shall be responsible for installation, maintenance and removal of temporary sanitary facilities per MIOSHA regulations for use of construction personnel including the Owner and Engineer. Rules and regulations of the State and local health officials shall be observed, with precautions taken to avoid creating unsanitary conditions.

1.07 POTABLE WATER

- A. Contractor shall furnish a supply of potable water per MIOSHA requirements, available for use of construction personnel including the Owner and Engineer.

1.08 MEDICAL SERVICES AND FIRST AID

- A. Contractor shall furnish first aid supplies and a person trained in first aid with a valid first aid certificate, per MIOSHA requirements, available for use of construction personnel including the Owner and Engineer. Contractor shall also furnish a communication system for contacting emergency services. The telephone numbers of the physician, hospital, or emergency services shall be conspicuously posted at the job site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 TRANSPORTATION AND HANDLING

- A. Contractor shall provide for expeditious transportation and delivery of materials and equipment to the Project site in an undamaged condition and on a schedule to avoid delay of the Work. Materials and equipment shall be delivered in original containers or packaging with identifying labels intact and legible.
- B. Contractor shall provide equipment and personnel at the site to unload and handle materials and equipment in a manner to avoid damage. Materials and equipment shall be handled only at designated lifting points by methods to prevent bending or overstressing.

1.02 STORAGE AND PROTECTION

- A. Contractor shall store materials and equipment immediately on delivery and protect it until installed in the Work.
- B. Products subject to damage by elements shall be stored in weather-tight enclosures with temperature and humidity ranges as required by manufacturer's instructions.
- C. Loose granular materials shall be stored on solid surfaces to prevent mixing with foreign matter.
- D. The place of storage shall be located so as to minimize interference with traffic and to provide easy access for inspection. No material shall be stored closer than 5 feet (1.5 meters) to the edge of a pavement or traveled way open to the public.
- E. Materials that have been stored shall be subject to retest and shall meet the requirements of their respective specifications at the time they are to be used in the Work.
- F. Contractor shall provide protection of stored or installed materials and equipment as necessary to prevent damage from traffic and subsequent operations.

1.03 MANUFACTURER'S INSTRUCTIONS

- A. When the Contract Documents require that installation of Work shall comply with manufacturer's instructions, the Contractor shall obtain and distribute copies of such instructions to parties involved in the installation including two (2) copies to the Engineer.
- B. Contractor shall handle, install, connect, clean, condition and adjust products in strict accord with such instructions and in conformity with specified requirements. Should Project conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.

1.04 PRODUCTS LIST

- A. Within four (4) days of request, the Contractor shall submit a complete list of major products proposed to be used, with the name of the manufacturer and the installing subcontractor, if applicable, to the Engineer.

1.05 CONTRACTOR'S PRODUCT OPTIONS

- A. For products specified only by reference standard, the Contractor shall select any product meeting that standard.
- B. For products specified by naming several products or manufacturer's the Contractor shall select any one of the products or manufacturers named, which complies with the specifications.
- C. For products specified by naming one or more products or manufacturers and "or equal," the Contractor must submit a Substitution Request Form for any product or manufacturer not specifically named, in accordance with Section 00 72 00 - General Conditions.

- D. For products specified by naming only one product and manufacturer, there is no option.

1.06 EQUIPMENT STARTUP AND TESTING

- A. Contractor shall perform a comprehensive startup and demonstration of equipment performance and compliance with the design requirements. When there is more than one mode of operation, the equipment shall be operated in every mode to verify proper operation.
- B. When equipment is to operate in conjunction with other equipment as a system, each piece of equipment shall be operated both by itself and automatically as a system to verify its proper operation.
- C. Contractor is to provide to the Engineer, in advance of startup, a schedule and listing of startup and testing procedures for review by the Engineer. Checklists and diagrams may be required to ensure adequate startup and testing. Engineer may recommend changes to the startup procedure as necessary.
- D. All equipment is to be inspected prior to operation for debris or other obstructions. Equipment is to be properly lubricated and calibrated prior to operation. Contractor shall make all adjustments necessary to assure correct operation. When required, equipment installation and operation is to be witnessed and checked by manufacturer.
- E. When required, the Contractor shall train the Owner's operation and maintenance personnel in the proper operation and maintenance of each piece of equipment and the system as a whole.
- F. Equipment startup is to be witnessed by the Owner and the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23 CONSTRUCTION LAYOUT

PART 1 GENERAL

1.01 RESPONSIBILITY FOR STAKING

- A. Owner will set stakes and markers showing the locations on the surface of various parts of the Work as outlined herein. Additional stakes shall be provided at the expense of the Contractor. Contractor shall furnish such labor and assistance as the Owner may require in setting the same.
- B. It shall be the responsibility of the Contractor to transfer surface line and grade to the bottom of any tunnel or to the bottom of any other subsurface operations where ordinary surface line and grade is not feasible.
- C. Contractor shall utilize lasers, or surveying instruments run by qualified competent personnel to control the construction installation Work. If the method being used by the Contractor fails to give proper alignment and grade control to the Work, the Owner shall be empowered to order the Contractor to use such other method(s) as will provide adequate control.
- D. Engineer may require the Contractor, at the Contractor's expense, to provide such masts, scaffolds, batter-boards, straightedges, templates, or other devices as may be necessary to facilitate laying out, observing and constructing the Work.
- E. In the event the Contractor presumes a staking inconsistency, the Contractor shall notify the Engineer immediately to assist in resolving the concern.

1.02 STAKING SCHEDULE

- A. Contractor shall submit a completed staking schedule on the form provided by the Engineer showing the order in which the Contractor proposes to conduct the construction operation prior to the preconstruction meeting. The schedule shall be submitted to the Engineer a minimum of three (3) working days prior to the start of construction.
- B. During construction, the Contractor shall to the extent possible, limit unnecessary staking requests and coordinate the construction schedule to provide for the efficient and effective use of the survey crew and eliminate excessive survey crew trips to the site.

1.03 LINE AND GRADE

- A. Contractor shall request, three (3) working days in advance, from the Engineer additional line and grade stakes as the Contractor may reasonably protect and preserve. Such request by the Contractor shall be on a staking request form.

1.04 RELOCATION AND RE-ESTABLISHMENT

- A. Construction Stakes:
 - 1. Where change of location of stakes has been requested by the Contractor, or where the Contractor fails to properly preserve construction survey stakes, such resetting or relocations of stakes shall be done by the Engineer and paid for by the Contractor on the basis of time and materials for such re-staking.
- B. Survey Control Points:
 - 1. Contractor shall bear all expense involved in re-establishing and/or resetting any survey control point, land survey point or monument lost or disturbed during his construction operation. Such Work shall be done under the direct supervision of a licensed land surveyor. Such survey control points shall be marked and flagged by the Engineer prior to construction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 77 00 CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 CLEANING

- A. Contractor shall perform periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and wind-blown debris, resulting from construction operations.
- B. Waste material, debris and rubbish shall be periodically removed from the site and disposed of at legal disposal areas away from the site.
- C. Prior to Owner acceptance, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces, and all Work areas, to verify that the entire Work is clean.
- D. Contractor shall broom clean exterior paved surfaces and rake clean other exterior surfaces of the site.

1.02 PROJECT RECORD DOCUMENTS

- A. Contractor shall deliver one (1) copy of all Specifications, Plans, Addenda, Shop Drawings and Samples, annotated to show all changes made during the construction process, to Engineer upon completion of the Work. Submittal of the record documents shall be made with a transmittal letter containing:
 - 1. Date
 - 2. Project Title and Number
 - 3. Contractor's Name and Address
 - 4. Title and Number of each Record Document
 - 5. Certification that each Document as submitted is complete and accurate
- B. Record Documents
 - 1. Shall be a complete set based upon the fully conformed Project Manual. annotations shall include all changes during the execution of the work resulting from Requests of Information, Field Orders, Construction Change Directives, and the as-built conditions which differ from the proposed plans.
 - 2. Underground utilities installed as part of the Project and utilities exposed during execution of the Work shall be surveyed to record their location and elevation. The location shall be based upon available Project data (i.e., coordinate system, benchmarks, etc.).
 - 3. The utility information shall include:
 - a. Straight run data every 100-feet.
 - b. Bends, valves, fittings, wyes/tees, hydrants, etc.
 - c. Crossings of other utilities.
 - 4. The record plans shall be in Portable Document Format (pdf), and full size (22" x 34").
 - 5. Annotations:
 - a. dimension changes with strike through and as built dimension.
 - b. changes clouded.
 - c. sketches, photos, etc. as appropriate.
- C. Documents shall be submitted in good order and in a legible condition.

1.03 OPERATION AND MAINTENANCE DATA

- A. Prior to final inspection or acceptance, Contractor shall fully instruct Owner's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and systems specified.
- B. Operation and maintenance data required by the individual Specification sections and the manufacturer's operation and maintenance data required in Section 01 33 00 - Submittal Procedures, shall constitute the basis of such instruction.

1.04 START UP

- A. Contractor shall coordinate efforts between Owner, Engineer, any equipment manufacturers, subcontractors and governing agencies in the start up of applicable portions of the Work.

1.05 WARRANTIES

- A. Written warranties from the manufacturer shall be provided for major equipment supplied under this Contract. The manufacturer's warranty period shall be concurrent with the Contractor's warranty period. The warranty from the manufacturer shall not relieve the Contractor of the one-year warranty starting at the time of Project Substantial Completion. Owner can request written warranties for equipment not classified as major.

1.06 SUBSTANTIAL COMPLETION

- A. Certification that the Work is substantially complete shall be in accordance with the General Conditions.

1.07 FINAL PAYMENT AND ACCEPTANCE

- A. The final inspection, final application for payment and acceptance shall be in accordance with the General Conditions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 89 00
SITE CONSTRUCTION PERFORMANCE REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes general performance requirements for earthwork complete with, removal and disposal of structures and obstructions, protection of existing sewers, tiles and mains; protection of existing building and improvements, protection of trees and other types of vegetation, protection of utility lines, requirements for pavement replacement, restoration of driveways and parking areas, restoration of sidewalks, restoration of lawns and disturbed areas, transportation and disposal of excess excavation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 57 13 - Temporary Erosion and Sediment Control
- B. Section 31 23 13 - Subgrade Preparation
- C. Section 31 23 16 - Structural Excavation and Backfill
- D. Section 31 23 33 - Trenching and Backfilling
- E. Section 32 13 15 - Sidewalks and Driveways

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. MDOT: Michigan Department of Transportation Standard Specifications for Construction, latest edition.
 - 2. ASTM D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

1.04 REQUIREMENTS OF REGULATORY AGENCIES

- A. Contractor shall comply with Section 01 57 13. Contractor, at Contractor's expense, shall secure all permits, and post all bonds or deposits required to comply with the Soil Erosion and Sedimentation Control, requirements, being Part 91 of PA 451 of 1994 as amended.
- B. Contractor shall comply with all requirements of the National Pollutant Discharge Elimination System (NPDES) Storm Water Program for Construction Activities, Part 31 of PA 451 of 1994 as amended.
- C. Contractor shall provide, maintain and remove such temporary and/or permanent Soil Erosion and Sedimentation Control measures as specified on the Plans or as determined by the Engineer.
 - 1. The measures shall prevent surface runoff from carrying excavated materials into the waterways, to reduce erosion of the slopes, and to prevent silting in of waterways downstream of the Work.
 - 2. Measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.

1.05 SUBMITTALS

- A. Written permission for the use of all disposal and borrow sites shall be obtained and copies shall be furnished to the Engineer.

1.06 PROTECTION OF PLANT LIFE

- A. All trees, shrubs, and other types of vegetation not within the limits of the Work or not designated on the Plans or by the Engineer to be removed, shall be carefully protected from damage or injury during the various construction operations.
- B. Any tree, shrub or other type of vegetation not designated to be removed but which is damaged by the Contractor's operation shall be repaired or replaced by the Contractor, at Contractor's expense, as determined by the Engineer.

1.07 PROTECTION OF EXISTING STRUCTURES AND IMPROVEMENTS

- A. Existing culverts, sewers, drainage structures, manholes, water gate wells, hydrants, water mains, utility poles, overhead lines, underground conduits, underground cables, pavement, or other types of improvements within the construction limits, not designated on the Plans to be removed, shall be carefully protected from damage during the construction operations.
- B. Existing structure or improvement not designated to be removed, but which is damaged by the Contractor's operations shall be repaired or replaced by the Contractor, to the satisfaction of the owner, at Contractor's expense.
- C. Deposits of dirt or debris in sewers, culverts, tiles, drainage structures, manholes, gate wells, etc. caused by the Contractor shall be cleaned out at the Contractor's expense.

1.08 MAINTAINING DRAINAGE

- A. Existing open drains, field and roadway ditches, drainage tile, sewers, enclosed drains, natural and artificial watercourses, surface drainage or any other types of drainage within the limits of the Work shall be maintained and free to discharge during construction.
- B. Drainage facility not designated to be abandoned, but which is damaged, or any drainage interrupted by the Contractor's operation shall be immediately repaired, replaced, or cleared by the Contractor.
- C. Costs incurred shall be incidental to the excavating, backfilling and compacting or grading operations.

PART 2 PRODUCTS

2.01 GRANULAR MATERIAL

- A. Bank run sand meeting the requirements of MDOT, Granular Material Class II.

2.02 AGGREGATE FOR SHOULDERS, PARKING AREAS, DRIVEWAYS OR ROADS

- A. Crushed Limestone, Natural Aggregate or Slag and meeting the requirements MDOT Section 902.

PART 3 EXECUTION

3.01 DEWATERING

- A. The area within the vicinity of the new Work shall be dewatered prior to commencing any construction activities. The depth of the dewatering shall be sufficient to allow the Work area to remain in a dry condition during the various construction operations.
- B. The costs incurred for furnishing, installing, maintaining and removing the dewatering equipment shall be at the Contractor's expense.
- C. Refer to Section 31 23 19 for additional requirements.

3.02 GENERAL

- A. The various construction operations shall be restricted to the existing right-of-way or the areas indicated on the Plans. If the Contractor requires additional area, the Contractor shall furnish

the Engineer with written permission obtained from the property owner for any part of the operations he conducts outside of the right-of-way or limits indicated.

3.03 EXISTING IMPROVEMENTS

- A. Contractor shall expose existing sewers and structures to which the new Work is to be connected and notify the Engineer of same. Engineer will verify the vertical and horizontal locations of the existing system and shall inform the Contractor as to the necessary adjustments required to align the new Work with the existing system.

3.04 EXISTING UTILITIES

- A. When existing utilities are shown on the Plans, their locations are approximate only, as secured in the field investigation and/or from available public records. Contractor, prior to the start of construction, shall contact 811 and the public agency or utility having jurisdiction to request the verification of all utilities within the construction area.
- B. When existing utility lines, structures or utility poles are encountered during the performance of the Work, the Contractor, at Contractor's expense, shall perform construction operations in such a manner that the service will be uninterrupted.
- C. Contractor shall expose all existing utility lines prior to any excavation operation, to determine any conflict with the proposed improvement. Contractor shall be responsible for any relocation required as a result of any conflict of existing utilities shown on the plans, with the proposed improvement.
- D. Should it become necessary to move any utility structure, line or pole shown on the Plans or otherwise found necessary to be moved, the Contractor shall make all arrangements with the owner of the utility for the moving. Costs incurred for such moving shall be at the Contractor's expense unless indicated otherwise. However, before disturbing a utility line, structure or pole, the Contractor shall furnish the Engineer with satisfactory evidence, in writing, that proper arrangements have been made with the owner of the utility.

3.05 UTILITY POLES

- A. Contractor shall be responsible for any removal or relocation required as a result of any conflict of existing utility poles (including street light poles, guy poles, telephone poles, etc.) with proposed improvements.
- B. Contractor shall make all arrangements for removing or relocating utility poles with the owner of the utility pole.
- C. Prior to disturbing any utility pole, the Contractor shall provide the Engineer with written evidence that proper arrangements have been made with the owner of the utility pole.
- D. When required by the Work, Contractor shall temporarily support poles in the vicinity of the Work at no additional cost to the Owner. Support shall be in accordance with and to the satisfaction of the utility company.

3.06 EXISTING SEWERS, TILE, AND MAINS

- A. Existing sanitary sewers, storm sewers, drain tile, septic tank bed tiles, water mains or building services or leads, that are encountered during the performance of the Work that require relocation or are damaged, shall be restored with new materials equal in quality and type to the materials encountered.
- B. The new material shall be installed as specified in the Contract Documents and per the requirements of the local agencies. The bedding and backfill material, unless otherwise specified, shall be an approved Class II granular material, compacted to 95% of its maximum unit weight.
- C. Seepage bed tile and water mains shall be replaced in accordance with the requirement of the agency having jurisdiction.

- D. The relocation or protection of existing sewers, tiles, tile field, water mains or building services and leads shall be at the Contractor's expense, unless otherwise indicated in the Contract Documents.

3.07 EXISTING STRUCTURES

- A. Existing surface and subsurface structures may be shown on the Plans, in locations considered most probable from information secured in the field investigation or from available public records.
- B. Neither the correctness nor completeness of such information is guaranteed or implied.
- C. Structures shall be protected, preserved or restored by the Contractor, to the satisfaction of the structure owner, at no additional cost to the Project.

3.08 EXISTING BUILDINGS

- A. Existing buildings or structures may be encountered throughout the Project within limits of the presently established right-of-way or easement. Good construction methods and procedures shall be employed by the Contractor, at Contractor's expense, to protect the structures.
- B. When it becomes necessary for the Contractor to move one of these buildings or structures in order to proceed with construction, the Contractor, at Contractor's expense, shall exercise all due care in moving the building or structure to prevent undue damage.
- C. Prior to moving an existing building or structure, the Contractor shall furnish the Engineer with satisfactory evidence, in writing, that proper arrangements have been made with the owner.
- D. Unless otherwise specified in the Contract Documents, the length of the move shall be maintained to a minimum which will allow for construction of the improvement.

3.09 REMOVAL OF SEWERS AND CULVERTS

- A. Unless otherwise specified in the Contract Documents, the Contractor, at Contractor's expense, shall remove any abandoned culvert, pipe, sewer, structure or part of a structure which is to be replaced or rendered useless by the new construction.
- B. When a sewer or culvert is removed at a structure, the Contractor shall install a masonry bulkhead in the structure.
- C. Removal of a culvert or sewer also includes the removal and disposal of any end treatments or headwalls.

3.10 REMOVAL OF STRUCTURES

- A. The removal of existing structures shall consist of removing and salvaging the existing frame and cover. The ends of the existing pipe shall be plugged and braced. The complete structure shall be removed entirely and disposed of. The excavation shall be backfilled with sand and compacted to 95% of its maximum unit weight. Maximum unit weight shall be determined by ASTM D698, Method B.
- B. If a structure is to be removed from a system that is to remain in service, a bypass system, approved by the Engineer, shall be installed and maintained by the Contractor, during the rebuilding period.

3.11 ABANDONING STRUCTURES

- A. The structure shall be broken down to at least 30 inches below the subgrade.
- B. Pipes connected to the structure shall be plugged with a brick, masonry or concrete bulkhead approved by the Engineer.
- C. The structure shall be backfilled with flowable fill to 12 inches above the pipes and the remainder of the structure backfilled with sand-cement mixture at a 10 to 1 ratio to subgrade elevation or to 12 inches below finished grade.

- D. The remainder of the excavation shall be backfilled with a granular material, compacted to 95% of its unit weight, and shall meet with the approval of the Engineer. Maximum unit weight shall be determined by ASTM D698, Method B.

3.12 SALVAGED MATERIAL

- A. Salvaged materials shall become the property of the Contractor unless otherwise specified in the Contract Documents, and shall be disposed of by the Contractor, at Contractor's expense.

3.13 REMOVING PAVEMENT

- A. The removal of concrete and bituminous pavement as called for on the Plans shall consist of removing and disposing of pavement and shall include base courses, surface courses, integral and separate curbs, integral and separate curb and gutters, sidewalks and end headers.
- B. The pavement shall be removed to an existing joint or cut parallel to the existing pavement joints.
- C. The cutting shall be accomplished by using a power-driven concrete saw approved by the Engineer. The depth of the saw cut shall be a minimum of 6 inches, to insure that the removal of the old pavement will not disturb or damage the section of pavement remaining in place.
- D. Residual concrete pavement shall not be less than 5 feet measured transversely, nor less than 6 feet longitudinally measured from a joint.
- E. In removing a concrete base course, where part of the existing bituminous surface is to remain in place, the bituminous surface shall be cut the full depth by the use of a power-driven saw, approved by the Engineer along a line parallel to and at least 12 inches from either side of the base course removal.
- F. Old pavement with a concrete cap shall be considered as only one (1) pavement, whether or not there is a separation layer of earth, aggregate, or bituminous material between the old material and the concrete cap.
- G. Removal of Curb for Curb Drop:
 - 1. Where curb is to be removed for a curb drop, the operation shall be performed by saw cutting or by cold milling, approved by the Engineer, so as to leave a neat surface with a maximum 1 inch lip, without damage to the underlying pavement.
- H. Removal of Curb and Gutter:
 - 1. Where curb and gutter are to be removed, the operation shall be performed by saw cutting. The limits of the removal shall be as called for on the Plans, or as approved by the Engineer. However, in no case shall the width of removal be less than 18 inches for sections with rolled or straight curb or less than 24 inches for mountable curbs.
- I. If during the pavement removal operation any concrete or bituminous pavement or surfacing is damaged beyond the removal limits designated, the damaged pavement or surfacing shall be removed and replaced at the Contractor's expense.
- J. Any earth which may be removed during the pavement removal operation shall be replaced by backfilling to the proposed subgrade with a suitable material, approved by the Engineer, at the Contractor's expense.

3.14 HOLES

- A. Earth removed during any phase of the excavation or removal operations, resulting in a hole or void, shall be replaced by backfilling to the proposed subgrade with a suitable granular material. The material shall be placed by the controlled density method or other effective means having the approval of the Engineer and shall be compacted to 95% of maximum unit weight.
- B. The furnishing, placing and compacting of the backfill material shall be at the Contractor's expense.

3.15 RESTORATION IN RIGHT-OF-WAY AND YARD AREAS

- A. The right-of-way and yard areas not paved or aggregate surfaced shall be restored in accordance with the type and location specified herein unless indicated otherwise on the Plans. The disturbed areas may be shaped by "Machine Grading" or another method approved by the Engineer to achieve the cross section, line and grade shown on the Plans. Areas where slopes are 1 on 4 or flatter shall be restored with topsoil, seed and mulch. Slopes steeper than 1 on 4 shall be restored with sod.
- B. Excess material from the restoration operation shall be disposed of by the Contractor at Contractor's expense.
- C. Disturbed areas shall be graded to receive either topsoil and seed or topsoil and sod. The topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 92 19 or 32 92 23.
- D. Contractor, at Contractor's expense, shall furnish, place, and compact any additional fill, meeting the approval of the Engineer, needed to restore the disturbed areas to the cross sections called for on the Plans or as determined by the Engineer.

3.16 RESTORATION OF AGGREGATE SURFACES

- A. Shoulders:
 - 1. The shoulder shall be regarded as the area between the edge of pavement and the ditch, or the area within 10 feet of the pavement, whichever is the lesser.
 - 2. The backfilling of trenches in the shoulder area shall be carried to within 5 inches of the existing surface as specified under Trench "A" or Trench "B" of Section 31 23 33. The remaining depth shall be backfilled with a minimum of 5 inches of compacted 22A or 23A aggregate with calcium chloride applied, at the rate of 6 pounds per ton of aggregate.
 - 3. Contractor, at Contractor's expense, shall furnish, place and compact all materials necessary to complete the backfilling and restoration operation within the shoulder area.
- B. Driveways and Parking Areas:
 - 1. Aggregate driveway areas shall be regarded as the area from the right-of-way line to the edge of the traveled roadway and shall include the shoulder area.
 - 2. The backfilling of trenches crossing aggregate surfaced driveways and parking areas shall be carried to the bottom of the proposed base course as specified under Trench "B". The remaining depth shall be backfilled with a minimum of 6 inches of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per ton of aggregate.
 - 3. Any aggregate surfaced areas beyond the limits of the actual excavation which are disturbed, as determined by the Engineer, by such operations as temporary storage of materials or passage of equipment, shall be resurfaced, at the Contractor's expense.
 - a. The upper three 3 inches of disturbed areas shall be removed as necessary to allow the final elevation of the resurfacing course to be at the elevation of the drive or parking area which existed prior to excavation.
 - b. Disturbed area shall be resurfaced with a minimum of 3 inches of 22A or 23A compacted aggregate, with calcium chloride applied at the rate of of aggregate.
 - 4. Contractor, at Contractor's expense, shall furnish, place, and compact all materials necessary to complete the backfilling and restoration operations within the driveway and parking area.
- C. Roads and Streets:
 - 1. Backfilling of trenches crossing aggregate surfaced roads or streets shall be carried to within 12 inches of the existing surface as specified under Trench "B" of Section 31 23 33.

The remaining depth shall be backfilled with two 6 inches layers of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per ton of aggregate.

2. Contractor, at Contractor's expense, shall furnish, place, and compact all materials necessary to complete the backfilling and restoration operations within the roadway or street area.
3. Also, any settlement of the aggregate surface shall be restored by placing additional aggregate, up to the original grade, and shall be done at the Contractor's expense.

D. Compaction

1. Compaction of aggregate shall be performed by a pneumatic-tired roller or a vibratory compactor until the material forms a stable surface.

3.17 RESTORATION OF PAVED SURFACES

- A. Contractor shall furnish and provide the materials necessary to complete the backfilling and restoration operations, which shall include furnishing, compacting, forming, placing, rolling, floating, jointing, finishing, curing and providing protection against elements.
- B. Restoration of any roadways that are partially damaged shall include a minimum replacement of one (1), full width lane of roadway. The length of replacement shall be at least equal to the width.
- C. Concrete:
 1. The backfilling of trenches crossing concrete driveways, sidewalks, roads, streets or parking areas shall be carried to the bottom of the proposed pavement as specified under Trench "B" of Section 31 23 33.
 2. Unless otherwise specified on the Plans or as determined by the Engineer, the concrete removed shall be replaced with 3500 psi concrete of the thickness removed and shall include reinforcing equal to the existing, if the existing pavement was reinforced.
 3. The construction of concrete pavements shall be in accordance with Section 32 13 13.
 4. Restoration of sidewalks shall also include the construction of sidewalk ramps at the intersection of the curb and shall conform to the current rules and regulations of the state of Michigan and to Section 32 13 15, and unless otherwise indicated in the Proposal, shall be considered incidental to the Project.
- D. Bituminous
 1. The backfilling of trenches crossing bituminous driveways, sidewalks, roads, streets or parking areas shall be carried to the bottom of the base course as specified under Trench "B" of Section 31 23 33.
 2. Bituminous pavement or bituminous surface course with an aggregate base shall be replaced in accordance with Section 32 12 16.
 3. Bituminous surfaced areas beyond the limits of the actual excavation which are disturbed by such operations, as temporary storage of materials or passage of equipment, shall be resurfaced with an approved bituminous mixture the same thickness as removed, but in no case less than 2 inches in thickness. Replacement material shall extend to smooth-cut edges, shall be uniform in direction and shall be at an elevation which provides a uniform surface between the undisturbed abutting surfaces.
 4. Restoration of any bituminous chip seal shoulders that are damaged or partially damaged, as determined by the Engineer, shall include complete replacement full width and length (extending a minimum of 25 feet beyond the damaged area both ways). Existing bituminous chip seal shoulders shall be brought to proper grade with compacted 22A or 23A aggregate and resurfaced with a double chip seal per Section 32 12 16.

3.18 SOIL EROSION AND SEDIMENTATION CONTROL

- A. Contractor shall comply with the requirements of Section 01 57 13. Prior to commencing any type of earthwork, the Contractor shall obtain a Soil Erosion and Sedimentation Control permit from the local enforcing Agency.
- B. Contractor shall obtain all approvals, secure all permits and post all bonds and deposits required to comply with the Soil Erosion and Sedimentation Control Act, Part 91 of PA 451 of 1994, as amended, and those of the enforcing agency.
- C. Contractor shall provide the Engineer with a copy of the soil erosion permit issued by the local enforcing agency for the Project, prior to commencing any type of earthwork on the Project.

3.19 EXCESS EXCAVATION

- A. Excess excavation shall be defined as all surplus earth material realized from the construction that is free of brush, roots, stumps, broken concrete, pipe, debris, and other extraneous material.
- B. Contractor, when requested by the Owner, shall transport all excess excavation to a site(s) designated by the Owner.
 - 1. The excess excavation shall be graded by the Contractor to provide positive surface drainage of the site(s).
 - 2. Grading shall be done such that adjacent properties are not damaged or affected. The grading shall include removal of all surface irregularities to provide a smooth surface ± 3 inches.
- C. When the excess excavation has not been requested by the Owner, the Contractor shall remove and properly dispose of the material at no additional cost to the Owner.
- D. Proper disposal of all excess excavation, including transportation, grading, and protection of adjacent properties shall be considered as a final cleanup item. No additional payment will be made for this item.
- E. Brush, roots, stumps, broken concrete, pipe, debris, and other extraneous material from the construction shall become the property of the Contractor, and shall be disposed of per all applicable Laws, rules or regulations. Removal and disposal of this material shall be considered as part of final cleanup. No additional payment will be made for this item.
- F. Owner approval of the final site(s) condition in writing will be required prior to final payment authorization.

END OF SECTION

SECTION 02 41 00 DEMOLITION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work of this section includes, but is not limited to, demolition of and disposal of building materials, concrete and included reinforcement, brick or tile masonry, wood and metal framing, mechanical and electrical components, plumbing components, structural elements and appurtenances from structures and facilities as listed in this Section and/or identified on the Drawings which are required to be removed as necessary where encountered within the limits of excavation or as directed by the Owner:
 - 1. Demolish building, walkway, drive, steps, fencing and associated structures.
 - 2. Demolish all miscellaneous items as shown on the Drawings.
- B. Contractor shall coordinate with the agencies having jurisdiction with regard to requirements and permits.
- C. Notify Owner and adjacent neighbors of the date and time of the demolition at least 24 hours prior to commencing work.
- D. Contractor shall have competent Superintendent on site at all times when demolition work is taking place.
- E. Perform demolition work hours Monday through Friday between 7:00 AM and 6:00 PM. The Contractor may not start a demolition that cannot be completed in one day on a Friday. The Contractor may not leave a partially demolished site unattended over the weekend.
- F. Secure all necessary permits including, but not limited to, Building Permit to Demolish, Sewer Permit, and Hydrant Permit. If necessary, applicable sidewalk repair permit shall be secured. All permits are the Contractor's responsibility unless otherwise noted.
- G. Coordinate work performed to have utilities shut off for project location. Ensure there is no loss of utilities to surrounding properties.
- H. Notify MISS DIG prior to beginning work.
- I. Prior to demolition, walk through interior of structure to verify it is unoccupied and to confirm that all utilities have been properly disconnected.
- J. Take all necessary precautions to protect workers and the public, including but not limited to, warning signs, barricades, and fall protection. Eliminate unnecessary hazards before leaving the jobsite at the end of each day. Hazards such as missing sidewalks and demolition debris must be enclosed with yellow caution tape.
- K. Reinstall fall protection and safety precautions at the end of each workday.
- L. In the event of accidental damage to an adjacent property, speak with the property owner and notify Owner immediately. Contractor is liable for damage to neighboring property.
- M. Provide to Owner prior to, and as an additional condition of, payment for work performed, all pertinent verified original receipts from an approved land fill or dump site, evidencing that all waste material from the job site contracted herein was disposed of in a proper manner. Receipts shall bear the date, job address, location of land fill or dumpsite, cubic yardage dumped, and bear the signature of the Contractor's driver and receiving facility representative. In the event such land fill receipts are not provided, payment shall be withheld until it is received and approved thereof.
- N. Minimize noise, dust and inconvenience to neighbors. Contractor will provide labor and use hoses of sufficient length (minimum 100 lineal feet) to prevent the discharge of visible dust emissions to the outside air throughout demolition.

- O. Restore property as required herein and as shown on the Drawings.
- P. Property dimensions and quantities must be field verified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 23 16 - Structural Excavation and Backfill

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; Current Edition
- B. NFPA 241 - Standards for Safeguarding Construction, Alteration, and Demolition Operations; 2013 Edition

1.04 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor shall adhere to and disposal of all demolition materials in accordance with the requirements of all applicable ordinances, codes, statutory rules and regulations of federal, state and local authorities.
- B. Protect persons and property throughout progress of work. Proceed in such manner as to minimize spread of dust and flying particles and to provide safe working conditions for personnel. Contractor shall take any necessary precautions to capture all particles and construction debris within the site limits.
- C. Maintain circulation of traffic within area at all times during demolition operations.
- D. Obtain permission from the Owner before abandoning or removing any existing structures, materials, equipment and appurtenances.
- E. Make necessary arrangements with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work.

1.05 SUBMITTALS

- A. Demolition Plan:
 - 1. Submit to the Owner for review, a Demolition Plan describing proposed sequence, methods, and equipment for demolition and disposal of each structure.
 - 2. Pre-Demolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by building demolition operations.
 - 3. Methods of demolition and equipment proposed to demolish each structure.
 - 4. Copies of any authorizations and permits to perform work.
 - 5. Submit documentation confirming acceptance by landfill(s) or other disposal facilities of demolition materials.
 - 6. Accurately record actual locations of capped and active utilities and subsurface construction.
 - 7. Statement of Refrigerant Recovery signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION - GENERAL

- A. Wet down work during demolition operations to prevent dust from arising.

- B. For structures identified for demolition on the drawings, the Contractor shall completely remove the foundation below ground surface as well as basement walls in their entirety, and fill to level of adjacent ground with suitable material and compact in a manner that complies with requirements stated elsewhere in the Specifications, particularly Section 31 23 16 - Structural Excavation and Backfill.
- C. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings. Where piping or electrical lines are removed back to a functioning point, cut/cap/properly terminate the remaining functioning component.
 - 2. When pipes, conduits other equipment are removed, all fasteners for that equipment shall also be removed and all holes/damage to the existing structures from which the equipment was attached shall be filled and repaired with like materials.
- D. Mechanical/Electrical (including but not limited to Process equipment, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated:
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. When a piece of equipment is shown to be removed, it shall be assumed that the power feed to that piece of equipment including conduit/wire/starter shall also be removed unless shown otherwise.
 - 5. All piping interconnecting pieces of equipment and/or associated with the system to be removed shall be removed even if not specifically shown to be removed on the drawings. All pipe supports associated with removed piping shall be removed.
 - 6. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
 - 7. Remove concrete equipment bases for equipment to be removed to the building foundation/floor. Patch existing floor smooth with non-shrink grout or suitable epoxy finish for sure
 - 8. Where vents or other pipes/conduits that are to be removed pass through an existing roof/floor/wall that is to remain, the resulting hole in the roof/floor/wall shall be patched and made watertight to match the existing materials.
 - 9. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation, to allow for relocation where shown and to maintain the integrity of the grounding systems.
 - 10. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed and disposed of off-site as required. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitable plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site.
- E. Protect Existing Work to Remain:
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.

2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.
4. Patch as specified for patching new work.

F. Building/Structure Demolition:

1. Demolish concrete and masonry in small sections.
2. Wherever possible, sawcut materials to be removed. Where jackhammering or other destructive means are required, care shall be taken to protect existing remaining equipment/structures.
3. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
4. Remove structures to the lines and grades shown unless otherwise directed by the Engineer. Where no limits are shown, the limits shall be 4-inch outside the item to be installed. The removal of masonry beyond these limits shall be at the Contractor's expense and these excess removals shall be reconstructed to the satisfaction of the Engineer with no additional compensation to the Contractor.
5. After removal of parts of all of walls, slabs and like work which tie into new work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

3.02 BACKFILLING

- A. Do not use demolition debris as backfill material.
- B. Below-Grade Areas: Completely fill below grade areas and voids resulting from building demolition operations with granular backfill according to backfill requirements in Section 31 23 16 - Structural Excavation and Backfill.
- C. Backfill demolished areas to existing ground level or foundation level of new construction as specified elsewhere in the Contract Documents.

3.03 DISPOSAL

- A. Contractor shall dispose of reinforced concrete, masonry, contained steel or castings and other materials which are removed at an approved offsite location.
- B. Dispose of debris and other non-salvaged materials offsite in licensed landfills that are deemed appropriate for the types of debris to be disposed.
- C. Materials, equipment, and appurtenances removed, that are not designated for relocation, become property of Contractor. Haul from site and dispose of according to local, state and federal regulations.

3.04 RESTORATION

- A. Restore surface of areas affected by building demolition to match adjacent conditions or meet local codes, whichever is more stringent.

END OF SECTION

SECTION 03 01 30 CONCRETE REPAIR AND REHABILITATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Section Includes: Furnishing of materials, labor, tools, and equipment necessary to repair, patch, and restore poorly placed or deteriorated concrete; and repair of joints and reinforcing steel. This includes removal of deteriorated concrete, surface preparation and installation of repair materials at deteriorated areas, cracks, and joints in concrete floors, walls, and ceilings as indicated on the drawings and specified herein.
- B. Defects that require repair include tie holes, exposed steel, voids, holes, honeycombed areas, spalling, delamination, cracking, and other defects as determined by the Owner.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 03 11 00 - Concrete Forming
- C. Section 03 20 00 - Concrete Reinforcing
- D. Section 03 30 00 - Cast-in-Place Concrete
- E. Section 03 32 00 - Construction and Expansion Joints
- F. Section 03 60 00 - Grouting

1.03 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 201.1R-08 Guide for Making a Condition Survey of Concrete in Service
 - 2. ACI 546R Guide to Concrete Repair
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - 2. ASTM C157/C157M Test Method for Length Change of Hardened Cement Mortar and Concrete.
 - 3. ASTM C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing
 - 4. ASTM C882/C882M Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
 - 5. ASTM D412 Test Methods for Vulcanized and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
 - 6. ASTM D624 Test Methods for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - 7. ASTM D903 Test Methods for Peel or Stripping Strength of Adhesive Bonds.
 - 8. ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test.
- C. The Society for Protective Coatings (SSPC)
 - 1. SSPC-SP 13 Surface Preparation of Concrete

1.04 SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00.

- B. Submit manufacturer's data completely describing concrete repair materials for each type of product to be utilized in the concrete repair process. Include material descriptions; chemical composition, physical properties, test data, and mixing, preparation, and application instructions. Submittals shall include a written statement from the Contractor that all products are compatible with each other, and consistent with the warranty requirements of the project.
- C. Concrete Rehabilitation Qualifications:
 - 1. Submit the name and experience record of the concrete rehabilitation Contractor. Include a list of at least 5 of the Contractor's previous utility or industrial installations rehabilitated, and identify the responsible officials, architects and engineers concerned with the project, contact information, and approximate contract price.
- D. Rehabilitation program: For each phase of the rehabilitation process, including protection of surrounding materials and site during operations, describe in detail the materials, methods, equipment and sequence of operations to be used for each phase of the work.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The manufacturer of the specified product shall have been in existence, for a minimum of 10 years.
- B. Installer Qualifications: Work must be performed by a firm having not less than 5 years successful experience in comparable concrete repair and rehabilitation projects and employing personnel skilled in the restoration process and operations indicated.
- C. Source limitations: Obtain concrete patching and rebuilding materials, crack injection materials, corrosion inhibitors, sealants, all through one source from a single manufacturer.
- D. Construction Tolerances: Construction tolerances shall be as specified in Section 03 30 00, except as modified herein and elsewhere in the Contract Documents.
- E. Mockups: Install mockups for each type of concrete removal and patching, concrete repair, crack injection, and joint sealing to demonstrate the quality of materials and execution for approval by the Owner.
 - 1. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.
 - 2. The independent testing agency, or other inspection party representing the Owner, shall be present during the construction of the mockups.
 - 3. Quality Control testing, as required by this Specification, shall be performed on each mockup.
- F. Pre-installation conference: Prior to beginning any concrete repair or rehabilitation work, the Contractor shall meet with the Owner to thoroughly discuss the proposed work, techniques and schedule. Representatives of the Manufacturer and Installer of repair and rehabilitation materials, as well as the independent testing agency, shall attend the pre-installation conference.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.
- B. Store and condition the specified product as recommended by the Manufacturer.
- C. Store in a suitable location approved by the Owner at all times. Keep area clean and accessible. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.
- D. Handle materials carefully to prevent inclusion of foreign materials.

- E. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

1.07 PROJECT/SITE CONDITIONS

- A. Existing Conditions:
1. Hot Weather: ACI 305
 2. Cold Weather: ACI 306
 3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.
 4. Coordinate coatings application with other trades to assure adequate illumination, ventilation, and dust-free environment during application and curing of coatings.
 5. Maintain a safe work environment in accordance with Federal, State, Local and project site regulations and guidelines.

PART 2 PRODUCTS

2.01 REPAIR MORTAR

- A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementitious, non-sag mortar, specifically formulated for the repair of surface defects.
- B. Provide the mortar with a penetrating corrosion inhibitor.
- C. Repair mortar shall have the following properties:

Physical property	Value	ASTM Standard
Compressive strength (min) at 1 day at 7 days at 28 days	3000 psig 6000 psig 7000 psig	C109
Bond strength (min) at 28 days	2200 psig	C882 (modified)
Freeze/Thaw resistance (min) 300 cycles	98 percent	C666

- D. Provide a minimum repair thickness of 1/4 inch, unless otherwise indicated.
- E. Repair Mortar Manufacturer, or Equal
1. Sika Corporation, SikaTop 123 Plus

2.02 NON-SHRINK GROUT

- A. Provide non-shrink grout conforming to the requirements of Section 03 60 00.

2.03 CONCRETE MATERIALS CEMENT

- A. Cement:
1. Use Type II Portland cement unless otherwise indicated.
- B. Repair Concrete:
1. Where required, provide repair concrete composed of structural concrete with maximum one- inch coarse aggregate meeting the requirements of Section 03 30 00.
 2. Provide a minimum repair thickness of 3 inches.
- C. Cement Grout:
1. Provide cement grout that meets the requirements of Section 03 60 00.

2. Provide a minimum repair thickness of one inch.
- D. Miscellaneous Materials:
1. For concrete construction materials not covered specifically in this Section, conform to the requirements of Section 03 30 00.

2.04 AGGREGATE

- A. Obtain the permission of the manufacturer and Owner before using aggregate to extend repair mortar and non-shrink grout products.
- B. If allowed and unless otherwise indicated, provide aggregate consisting of 3/8-inch clean, washed gravel or crushed stone as required in Section 03 30 00.

2.05 BONDING AGENT AND ANTI-CORROSION COATING

- A. Provide a bonding agent that is a solvent-free, moisture-tolerant, epoxy-modified, cementitious product, specifically formulated as a bonding agent and anti-corrosion coating.

2.06 BONDING AGENT MANUFACTURER, OR EQUAL

1. Sika Corporation, Armatex 110 EpoCem.

2.07 EPOXY GROUT

- A. Provide an epoxy grout conforming to the requirements of Section 03 60 00.

2.08 EPOXY RESIN

- A. For crack injection, provide a 2-component, moisture-tolerant, low-viscosity, high-strength epoxy resin adhesive that is specially formulated for that usage.
- B. Provide a minimum bond strength of 2900 psig when tested per ASTM C882 at 14 days, moist cured.
- C. Epoxy Resin Manufacturer, or approved equal:
 1. Sika Corporation, Sikadur 35, Hi-Mod LV

2.09 PROTECTIVE COATING

- A. Waterproofing:
 1. Provide a 2-component, polymer-modified, cementitious waterproofing and protective slurry mortar for concrete.
 2. The waterproofing shall be certified as being in conformance with NSF 61.
 3. Apply the material in 2 coats, with a coverage of 40 sq ft/gal/coat.
 4. Waterproofing Manufacturer, or Equal
 - a. Sika Corporation, Sika Top Seal 107.

2.10 FORMWORK

- A. Where needed, provide formwork that meets the requirements of Section 03 11 00.

2.11 REINFORCEMENT STEEL

- A. Where required, provide reinforcing steel that meets the requirements of Section 03 20 00.

2.12 POLYURETHANE SEALANT

- A. Provide a 2-part polyurethane, gun-grade sealant, certified as being in conformance with NSF 61.
- B. Polyurethane Sealant Manufacturer, or approved equal:
 1. Sika Corporation, Sikaflex – 2C

2.13 POLYURETHANE CHEMICAL GROUT

- A. Use polyurethane chemical grout for non-structural crack repair
- B. Polyurethane Chemical Grout Manufacturer, or approved equal:
 - 1. Sika Corporation, SikaFix HH

2.14 HYDROPHILIC WATERSTOP

- A. Provide hydrophilic waterstop conforming to the requirements of Section 03 32 00.

PART 3 EXECUTION

3.01 GENERAL

- A. Repairs:
 - 1. Repair defects immediately after form removal.
 - 2. Repair techniques will be reviewed during the pre-construction meeting between the Contractor and Owner.
 - 3. The Contractor shall be familiar with the cause of deteriorated concrete and shall choose the right equipment, repair materials and techniques to be used for each particular repair.
 - 4. Choose repair materials to match the adjacent concrete surface in color and texture.
 - 5. Apply repair materials in strict accordance with the manufacturer's printed instructions, including temperature and moisture requirements throughout application and curing.
 - 6. Protect adjacent portions of the structure, including all pipes, and mechanical equipment, from debris generated by repair activities.
 - 7. For portions of the structure that are not identified to be repaired, maintain in their original condition.
 - 8. Dampen area to be patched and area at least 6 inches wide surrounding area to be patched for at least 24 hours to prevent absorption of water from patching mortar.
- B. Structural Stability:
 - 1. Use caution not to weaken the structural capacity of a beam, wall, slab, or other concrete member during concrete removal.
 - 2. For severely deteriorated concrete members, consult with the Owner before removing a major portion of any structural member.
 - 3. Shoring may be required in order to support the structure and to protect workers.
- C. Shoring:
 - 1. Contractor shall design the shoring to adequately distribute the load to the foundation in such a manner as to avoid damage to the structure.
 - 2. Maintain the shoring in place until all repairs are completed and structurally repaired areas have achieved their full 28-day design strengths.
- D. Provide off-site disposal of debris generated as a result of repair procedures.
- E. Provide concrete construction procedures not specifically addressed in this Section in accordance with the requirements of Section 03 30 00.

3.02 SUGGESTED REPAIR SEQUENCING

- A. Unless otherwise indicated, perform concrete repairs in the following sequence, with no activity in an area being started until previous activities in that area have been completed, including curing, cleanup, and the like:

1. Removal of equipment, miscellaneous metals, and other surface features that would interfere with the repair;
 2. Surface preparation hydroblasting over the entire area to be repaired;
 3. Embedded metal repair;
 4. Crack repair;
 5. Spalled and delaminated concrete repair;
 6. Scaled concrete repair;
 7. Pop-out repair, and repair of other surface damage, deterioration, or defects;
 8. Patching of holes in concrete;
 9. New construction; and
 10. Application of protective coatings;
- B. For areas which require combinations of spalled and delaminated concrete repair, scaled concrete, and pop-out repair, perform these repairs at the same time.
- C. Limit the size of the repair area in order to permit the repairs to be performed together, without sacrificing the quality of the individual repairs.

3.03 EMBEDDED METAL REPAIR

- A. Unless otherwise indicated, repair anchor bolts, structural steel from temporary support system, and other embedded metal, except rebar, that are exposed at the concrete surface, as follows:
- B. Cut off or otherwise remove metal fastened at the surface;
1. Burn back embedded metals to a depth of at least 1.5 inches beyond the surface of sound concrete. When removing hollow structural members, completely fill and patch the void over the entire member thickness;
 2. Chip away unsound concrete around the embedded metal.
 3. Apply epoxy grout to the repair area until level with the surface of the surrounding sound concrete.
- C. Unless otherwise indicated, repair embedded rebar that is exposed at the concrete surface following the procedures outlined in the appropriate concrete repair subsection, below.

3.04 CRACK REPAIR

- A. Structural versus Non-Structural Cracks:
1. Cracks are defined by the Owner as non-structural cracks or structural cracks.
 2. Repair structural cracks with epoxy resin.
 3. Repair non-structural cracks with polyurethane chemical grout.
- B. Efflorescence:
1. Prior to the crack repair, clean efflorescence from the cracks and the surrounding area.
 2. Clean the efflorescence by light hydro-blasting or scrubbing.
- C. Pressure Injection:
1. General:
 - a. The indicated repair materials have been selected to minimize the loss of material during the injection process. The areas selected for crack repair are to be identified by the Contractor and Owner.

- b. In order to avoid excessive loss of injected material at the lower exposed portions of the cracks, space the injection ports a distance no greater than the thickness of the wall being repaired.
- 2. Structural cracks are to be repaired to deliver a water tight hydraulic structure. Cracks greater than a minimum 0.01-inch are to be injected unless they do not accept grout. Perform structural crack repairs by pressure injection in accordance with the manufacturer's directions, and in accordance with the following basic procedure:
 - a. Rout the crack when unsound and foreign materials are present on the surface to establish the surface as a sound material.
 - b. Remove any contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. Any solvents must be fully flushed from the joint unless NSF 61 approved.
 - c. Install the injection ports in accordance with the manufacturer's directions.
 - d. Sealing:
 - 1) Seal the surface in order to keep the pressure injecting materials from leaking out before it has set or gelled.
 - 2) Seal a surface by brushing an epoxy over the surface of the crack and allowing it to harden.
 - 3) Use high injection pressures to cut-out the cracks in a 'V' shape, fill with an epoxy, and strike off flush with the surface.
 - 4) Surface patching or sealant shall be performed where needed to provide for complete penetration of the injected polyurethane grout and to prevent wastage. Seal surface of crack with fast setting hydraulic cement or high strength epoxy gel; i.e., Denepox Rapidgel by De Neef Construction Chemicals, Inc. or equivalent. The floor surface along the cracks shall be cleaned and all wasted grout and surface seal material shall be completely removed from the concrete surface following completion of the repair work
 - e. Inject the repair materials, with consideration of the following items:
 - 1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.
 - 2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, then cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled.
 - 3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.
 - 4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.
 - f. Cleanup:
 - 1) Remove the surface seal by grinding or other appropriate means.
 - 2) Coat fittings and holes at injection ports with an epoxy patching compound.
 - 3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.
- 3. Non-structural cracks are to be repaired to deliver a water tight hydraulic. Cracks greater than a minimum 0.01 inch are to be injected unless they do not accept grout. Perform

non-structural crack repairs in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

- a. Rout the crack when unsound and foreign materials are present on the surface to establish the surface as a sound material.
- b. Remove contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. Any solvents must be fully flushed from the joint unless NSF 61 approved.
- c. Install the injection ports in accordance with the manufacturer's directions.
- d. Moisture:
 - 1) For non-structural cracks, moisture must be present for the chemical grout to react.
 - 2) Prior to injecting the repair materials, inject the crack with a small amount of water in order to completely moisten the crack.
- e. Inject the repair materials, with consideration of the following items:
 - 1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.
 - 2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled, and then, starting again at the lowest port, re-inject into all ports in order to ensure that voids are properly sealed off.
 - 3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.
 - 4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end.
- f. Cleanup:
 - 1) Remove excess surface material by grinding or other appropriate means.
 - 2) Coat fittings and holes at injection ports with an epoxy patching compound.
 - 3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3.05 SPALLED AND DELAMINATED CONCRETE REPAIR

- A. Repair spalls and delaminated concrete using repair mortar.
- B. Surface Preparation:
 1. Remove all delaminated concrete and all unsound concrete beyond the spalled or delaminated area.
 2. Boundaries:
 - a. Determine the boundaries of the patch by sawcuts to a depth of at least 1/4 inch up to one inch deep.
 - b. Layout boundaries to reduce boundary edge length.
 - c. Avoid excessive or complex edge conditions.
 3. Sawcuts:
 - a. Perform sawcuts perpendicular to the surface or slightly undercut.

- b. Construct sawcuts in maximum 1/4-inch increments.
 - c. After each incremental cut, inspect the cut surface in order to ensure that the existing reinforcement has not been cut.
 - d. If at any depth the reinforcement becomes exposed, terminate the sawcut and notify the Owner.
- 4. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by patching material, whichever is greater.
- 5. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete such as wall, slab-on-grade, underside or top of elevated slab.
- 6. Removal:
 - a. The maximum allowable pneumatic chipping hammer shall be a 30-lb class hammer.
 - b. Hydroblast removal shall use a maximum pressure of 40,000 psig.
 - c. Sand blasting is not permitted.
 - d. Hydroblast concrete removal is recommended for large area of surface defects.
 - e. Remove water blasting debris daily in order to prevent it from setting up.
 - f. If a chipping hammer is used, ensure that the existing reinforcement is not damaged during the concrete removal operations.
 - g. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.
- 7. Reinforcement:
 - a. Remove concrete from around reinforcement when the rebar is rusted, more than half the rebar perimeter is already exposed, the concrete bond around the rebar is broken, and if the concrete is unsound or honey-combed.
 - b. Remove concrete in order to provide a clear space of minimum one inch on each side of the reinforcement, such that the rebar can be cleaned and the repair material will completely surround the rebar.
 - c. Clean exposed reinforcement by water blasting or wire brushing.
 - d. After fully exposing and cleaning the reinforcement, check for steel deterioration, and if the cross-sectional area of the steel has been reduced by more than 10 percent, whether by deterioration, surface preparation, or a combination of both, provide additional reinforcement.
 - e. Consult with the Owner before adding or replacing rebar.
- C. Repairing Surface Defects:
 - 1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning the reinforcement.
 - 2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.
 - 3. Remove dust, including new dust generated by surface preparation or scarifying.
 - 4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

D. Repair Mortar:

1. Apply repair mortar in accordance with the manufacturer's recommendations.
2. Apply a minimum and maximum thickness of each lift of repair material in accordance with the manufacturer's recommendations, with the minimum thickness being not less than 1/4 inch.
3. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.
4. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.
5. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.
6. Float-finish the repaired surface using wood or sponge floats.
7. For repaired surfaces to receive a protective coating, brush-finish the surface in order to produce a roughened substrate for the coating.
8. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

E. Curing:

1. Curing of repair mortar to receive waterproofing shall be as follows:
 - a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;
 - b. Weight the curing blankets or otherwise hold them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;
 - c. Ensure that edges are continuously held in place; and,
 - d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.
2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.
3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.06 SCALED CONCRETE REPAIR

A. Repair scaling and pop-outs using repair mortar.

B. Surface Preparation:

1. Prior to repair, prepare the surface in accordance with the repair mortar manufacturer's recommendations with the following minimum requirement.
2. Remove unsound concrete from surfaces by high-pressure water blasting, using a minimum pressure of 10,000 psig and maximum pressure of 40,000 psig.
3. Clean exposed reinforcement by water blasting or wire brushing.

C. Repairing Surface Defects:

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning reinforcement.
2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.
3. Remove dust, including new dust generated by surface preparation or scarifying.
4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.
5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.
6. Apply repair mortar in accordance with the manufacturer's recommendations, using a minimum repair material thickness of 1/4 inch.
7. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.
8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.
9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.
10. Float-finish the repaired surface using wood or sponge floats.
11. Provide strip joint in newly placed mortar at the location of repaired cracks.

D. Curing:

1. Curing of repair mortar to receive waterproofing shall be as follows:
 - a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;
 - b. Weight the curing blankets or otherwise hold them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;
2. Ensure that edges are continuously held in place; and,
 - a. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.
3. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.
4. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.07 POP-OUT REPAIR, AND REPAIR OF OTHER SURFACE DAMAGE, DETERIORATION, OR DEFECTS

- A. Repair pop-outs and other surface damage, deterioration, and defects which are 1/4 inch deep or shallower, using the procedures described under "SCALED CONCRETE REPAIR," above.
- B. Repair other pop-outs and surface damage, deterioration, and defects using the procedures described under "SPALLED AND DELAMINATED CONCRETE REPAIR," above.

3.08 PATCHING OF HOLES IN CONCRETE

- A. General:

1. For the purposes of this Section, holes are defined as penetrations completely through the concrete member and with interior surfaces approximately perpendicular to the surface of the existing member.
 2. Interior surface areas which are inclined and do not meet this criteria shall be chipped as needed to meet this requirement.
 3. The perimeter of holes at the surface shall form a regular shape composed of curved or straight line segments.
 4. Provide the minimum depth of placement for the material used; score the existing concrete by sawcutting, and chip as needed to meet this requirement.
 5. Roughen the interior surface of holes less than 12 inches in diameter to a minimum of 0.125-inch amplitude, and roughen larger holes to a minimum of 0.25-inch amplitude.
 6. At holes, coat the existing surface to be repaired with a bonding agent.
- B. Patching Small Holes:
1. For holes which are less than 12 inches in their least dimension and extend completely through concrete members, fill with non-shrink grout as required in Section 03 60 00.
- C. Patching Large Holes:
1. Fill holes which are larger than 12 inches in their least dimension with non-shrink grout.
 2. Provide large holes which are normally in contact with water or soil with hydrophilic waterstop placed in a groove, approximately 1/16 inch deep.
 3. Grind the groove into the interior edge of the hydrophilic waterstop.
 4. Alternatively, bond the hydrophilic waterstop to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material.
 5. Install the waterstop in accordance with the requirements of Section 03 32 00.
 6. Provide reinforcing steel in layers matching existing reinforcement location, except that concrete cover as required in the Contract Documents for the service condition shall be provided.
 7. For holes smaller than 48 inches, provide reinforcement consisting of a minimum of No. 5 bars at 12 inches on center in each layer required.
 8. At holes larger than 30 inches, drill the reinforcement and grout into the existing concrete.
 - a. For holes larger than 48 inches, refer to the Drawings for reinforcement details.

3.09 PATCHING OF LINED HOLES

- A. General:
1. This work applies to those openings which have embedded material over all or a portion of their inside edge.
 2. The requirements for repairing holes in concrete, as indicated above, apply as modified herein.
 3. Owner will determine whether the embedded material is allowed to remain.
 - a. Where embedded material is allowed to remain, trim it back a minimum of 2 inches from the concrete surface.
 - b. Roughen or abrade the embedded material in order to promote good bonding to the repair material.
 - c. Remove substances that interfere with good bonding.

- d. Completely remove embedded items that are not securely and permanently anchored into the concrete.
- 4. Completely remove embedded items which are larger than 12 inches in their least dimension, unless they are composed of a metal to which reinforcing steel can be welded; where reinforcement is required, weld it to the embedded metal.
- 5. The following requirements shall apply to concrete members which are in contact with water or soil:
 - a. Using epoxy grout, fill lined openings which are less than 4 inches in their least dimension;
 - b. Using an epoxy bonding agent, coat lined openings which are greater than 4 inches but less than 12 inches in their least dimension, prior to being filled with non-shrink grout.
 - c. Using an epoxy bonding agent, coat lined openings which are greater than 12 inches in their least dimension, and provide a hydrophilic waterstop bonded to the interior of the opening with epoxy adhesive, prior to being filled with approved repair material.

END OF SECTION

SECTION 03 11 00 CONCRETE FORMING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes formwork for cast-in-place concrete, complete with furnishing, preparation, installation, coating, protection, adjustment, removal and accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 15 00 - Concrete Accessories
- B. Section 03 20 00 - Concrete Reinforcing
- C. Section 03 30 00 - Cast-in-Place Concrete

1.03 DESIGN STANDARDS

- A. The formwork shall be designed for the loads, lateral pressure, and allowable stresses outlined in "Guide to Formwork for Concrete" ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the local building code. The design and construction of the formwork shall be the responsibility of the Contractor.
- B. The formwork shall be true in every respect to produce hardened concrete to the required shape, size, grade and alignment as indicated on the Plan, and of sufficient strength, bracing and rigidity to maintain their position and shape under the loads and operations incidental to placing and curing the concrete, as well as all other forces resulting from the movement of the forms.
- C. The forms shall be mortar-tight at the time concrete is placed in them and shall be so constructed that the surfaces of the finished concrete will be reasonably free from ridges, fins, offsets, or similar defects.
- D. Adequate and suitable means for removing the forms without injury to the surfaces or edges of the finished concrete shall be provided.

1.04 ALLOWABLE TOLERANCES

- A. Formwork shall be constructed such that the hardened surfaces shall conform to the tolerance limits of ACI 347R, except as modified below:
 - 1. Variation from plumb in lines and surfaces of piers, walls, or columns
 - a. In any 10 feet of length: 1/4 inch
 - b. Maximum for entire length: 1 inch
 - 2. Variation from the level or from the grades
 - a. In any 10 feet of length: 1/4 inch
 - b. Maximum for entire length: 3/4 inch
 - 3. Variation of distance between walls, columns and beams
 - a. In any 10 feet of distance: 1/4 inch
 - b. Maximum for entire distance: 1 inch
 - 4. Variation of the linear lines from established position as indicated on the Plan
 - a. In any 20 feet (6 m) of length: 1/2 inch
 - b. Maximum for entire length: 1 inch
 - 5. Variation in sizes and locations of sleeves, floor openings, and wall openings

- a. Minus: 1/4 inch
 - b. Plus: 1/2 inch
- 6. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls
 - a. Minus: 1/4 inch
 - b. Plus: 1/2 inch
- 7. Variations of footing dimensions from plan dimensions
 - a. Minus: 1/2 inch
 - b. Plus: 2 inch
- 8. Thickness \pm 5%, up to maximum of 1 inch

1.05 REFERENCE STANDARDS

- A. ACI 347R: Guide to Formwork for Concrete
- B. ASTM C31/C31M: Standard Practice for Making and Curing Concrete Test Specimens in the Field

1.06 SUBMITTALS

- A. Submit manufacturer's literature for form coating.
- B. Submit formwork layout plans, design data and procedures if requested by the Engineer.

1.07 STORAGE AND HANDLING

- A. Store and handle form coating to prevent contamination of coating in accordance with manufacturer's recommendations.

1.08 SEQUENCING

- A. Sequence installation of formwork with the Work of Section 03 20 00, Section 03 15 00, and Section 03 30 00.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Use lumber that is straight, uniform width and thickness, free from knots, offsets, holes, dents, warpage and other surface defects.
- B. Use plywood product of standard psi, waterproof, resin-bonded, exterior-type Douglas Fir, face adjacent to concrete shall be Grade B or better.
- C. Metal forms to be smooth metal plate free of surface irregularities.
- D. Chamfer Strips: Use clear white pine, surface against concrete planed, 1 inch bevel width or cant strip.

2.02 FORM COATING

- A. Use nonstaining form oil or other mineral oil which will neither discolor nor otherwise injuriously affect the concrete.

2.03 FORM TIES

- A. Use permanently embedded body type with removable end cones on outer ends, permanently embedded portion 1 inch back from concrete face.

2.04 FORMS - GENERAL

- A. Use forms that conform to ACI 347R. Fabricate with facing materials that produce the specified tolerance requirements outlined in Part 1 of this Section; produce true surfaces, sharp corners and true lines; and are free of offsets, ridges, bulging, waves and concave or convex areas.

2.05 LAYOUT

- A. Use regular and uniform pattern; long dimension of panels vertical; joints horizontal, vertical and aligned; form ties uniformly spaced and aligned in horizontal and vertical rows.

PART 3 EXECUTION

3.01 PREPARATION

- A. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms and embedded materials shall be cleaned of any mortar from previous concreting and of all other foreign material or water before coating is placed in them.
- B. Forms shall be coated in accordance with manufacturer's recommendations before the form or reinforcement is placed in final position. Surplus coating on form surfaces, or any coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.02 INSTALLATION OF FORMS

- A. Forms shall be sufficiently tight to prevent loss of mortar from the concrete, set true to the lines and elevations indicated on the Plans, tied and braced to remain true during and after concrete placement within tolerances outlined in Part 1 of this Section. The Engineer may at any time condemn any section or sections of forms found deficient in any respect, and such form shall be promptly removed and replaced.
- B. No wooden spreaders shall be allowed to remain in the concrete. No metal shall be within 1 inch of any surface.
- C. Place chamfer strips in forms to bevel all corners, edges, joints and other structural elements exposed to view, including use of dummy chamfer and false joints to provide neat and uniform appearance. Exposed corners and edges shall have 3/4 by 3/4 inch - 45 degree chamfers, unless otherwise indicated on the Plan.
- D. Provide temporary openings at the base of wall forms and at the other points when necessary to facilitate cleaning and inspection immediately before depositing concrete.
- E. Secure in position wedges used for final alignment and items to be embedded in concrete.
- F. Forms for keyways shall be prepared in advance of pouring concrete. Keyway forms in slab edges and vertical wall joints shall be rigidly secured in place before the concrete is poured. Forms for keyways for horizontal joints in walls may be placed at the conclusion of the pour, but proper provision shall be made for obtaining and holding the full depth and form of the keyway.

3.03 ADJUSTMENT OF FORMS

- A. Positive means of adjustment should be provided to permit realignment or readjustment of shores if excessive settlement occurs.
- B. A pair of wedges may be used at the top or bottom of shores, but not at both ends, to facilitate vertical adjustment, to correct uneven settlements, or to facilitate dismantling of the formwork.
- C. Screw jacks for pipe shores or scaffold-type shoring may be used at both top and bottom so long as they are secured by the shore or scaffold leg against loosening or falling out, to avoid lateral deflections.
- D. During and after concreting, but before initial set of the concrete, the elevations, camber, and plumbness of formwork systems shall be checked, using telltale devices. Appropriate adjustments shall be promptly made where necessary. If, during construction, any weakness

develops and the formwork shows any undue settlement or distortion, the Work shall be stopped, the affected construction removed if permanently damaged, and the formwork strengthened.

3.04 REMOVAL OF FORMS

- A. Forms, wedges or shoring shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all superimposed dead, temporary construction, and live loads. When forms or shoring are removed, there shall be no excessive deflection or distortion of the concrete. Forms shall be removed in an orderly fashion; with care to avoid surface gouging, corner or edge breakage, or other damage or injury to the concrete surface or physical property; and without impact or shock, to permit the concrete to carry its share of the loads gradually and uniformly. Form removal shall not impair the safety and serviceability of the structure or concrete members.
- B. Forms and shoring in the formwork used to support the weight of concrete in beams, slabs, and other structural members shall remain in place a minimum of 14 days or until the concrete has reached a minimum of 75% of the design compressive strength. The cylinder strength shall be based on test specimens cured in the field, as described in ASTM C31/C31M, under conditions which are not more favorable than the most unfavorable conditions for the portions of the concrete which the test specimens represent and shall be determined in accordance with Section 03 30 00.
- C. Formwork for columns, walls and other vertical members shall remain in place a minimum of five (5) days or until the concrete has attained a minimum of 75% of its design strength. Where such formwork also supports the formwork of beams and slabs, the removal times of the latter shall govern. Face and edge forms shall be removed as soon as practicable and permitted by the Engineer in order to facilitate effective repair of voids or broken corners before the surface has dried.
- D. Forms and shoring in the formwork shall not be removed without the approval of the Engineer. The minimum in-place times are for ordinary conditions and represent cumulative number of days, not necessarily consecutive, after the concrete was placed, during which the temperature of the air surrounding the concrete is above 50 degrees Fahrenheit. The times may be increased or decreased as directed by the Engineer, dependent on air temperatures, cement type, concrete additives or other conditions of the Work in accordance with ACI 347R.

3.05 RESHORING

- A. When removing forms before structural members are strong enough to carry dead load and/or construction loads, reshores shall be installed to assure safe distribution of loading. Reshoring operations shall be planned in advance and shall be subject to the Engineer's review. During reshoring, no construction loads shall be permitted on the new construction.
- B. Reshores shall be placed as soon as practicable after form removal, but in no case later than the end of the working day on which form removal occurs and shall remain in place until the concrete has acquired the required strength.

END OF SECTION

SECTION 03 15 00 CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes joint fillers, joint sealants, waterstops, and miscellaneous embedded items in concrete.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 - Concrete Forming
- B. Section 03 20 00 - Concrete Reinforcing
- C. Section 03 30 00 - Cast-in-Place Concrete

1.03 REFERENCE STANDARDS

- A. ASTM A193/A193M: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
- B. ASTM A194/A194M: Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- C. ASTM A563/A563M: Standard Specification for Carbon and Alloy Steel Nuts
- D. ASTM B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- E. ASTM D994/D994M: Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
- F. ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- G. ASTM D1752: Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- H. ASTM D6690: Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
- I. ASTM F436/F436M: Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
- J. COE CRD-C 513: Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops
- K. COE CRD-C 572: Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop

1.04 SUBMITTALS

- A. Submit certified manufacturer's affidavits for expansion joint filler, joint sealant and waterstops to verify compliance with the applicable Specifications.
- B. Submit a schedule of concrete pouring and indicate locations of proposed construction and expansion joints. This schedule is subject to approval of the Engineer.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Environmental requirements relative to temperature for placing joint sealants are specified in Part 3 of this Section.

1.06 SEQUENCING

- A. Contractor shall sequence installation of miscellaneous embedded items with the Work of Section 03 11 00, Section 03 20 00 and Section 03 30 00.

PART 2 PRODUCTS

2.01 JOINT FILLER

- A. Preformed Expansion Joint Filler for Concrete (Bituminous Type) ASTM D994/D994M.
- B. Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) ASTM D1751.
- C. Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Concrete ASTM D1752.

2.02 JOINT SEALER

- A. Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements ASTM D6690 Type II.
- B. Joint Sealants, Hot-Poured, Elastomeric Type, for Portland Cement Concrete Pavements ASTM D6690, Type II or III.

2.03 WATERSTOPS

- A. PVC waterstops shall conform to COE CRD-C 572 polyvinyl chloride (PVC) or COE CRD-C 513 styrene-butadiene rubber (SBR). Flat ribbed type shall be used in joints in walls and slabs where shown on the plans. Center bulb type shall be used in expansion joints.
- B. Bentonite waterstops shall be a compound of 75% high swelling sodium bentonite and 25% butyl rubber. Bentonite waterstops require an adhesive as recommended by the manufacturer to adhere the waterstop to the substrate.
- C. Hydrophilic rubber waterstop shall be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete. Hydrophilic rubber waterstops require an adhesive as recommended by the manufacturer to adhere the waterstop to the substrate.

2.04 CONCRETE ANCHORS

- A. General:
 - 1. Select type and size to achieve required loading capacity using information provided by manufacturer. If required type is not indicated, select type appropriate to conditions and item being fastened.
 - 2. Maintain critical edge distance and spacing per manufacturer's recommendations for all anchors. Provide tamper proof hardware when called for on the plans.
- B. Adhesive Anchors:
 - 1. Combination capsule adhesive and insert system; chisel pointed threaded rod with hex nut/washer, reinforcing bar, or internally threaded insert, installed into pre-drilled anchor hole using rotary hammer drill, crushing glass capsule containing two part epoxy acrylate resin (vinyl ester) with quartz aggregate and hardening agent, forming adhesive mortar.
 - 2. Threaded rod: ASTM A193/A193M Grade B7, ASTM A194/A194M Grade 2H or ASTM A563/A563M Grade DH nuts, and ASTM F436/F436M washers; plated in accordance with ASTM B633, SC1, with Type II yellow chromate treatment or Type 304 stainless steel when specified on the plans.
 - 3. Threaded Insert: Carbon steel tubular insert, internally threaded, plated in accordance with ASTM B633, SC1.
- C. Wedge Type Anchors:
 - 1. One piece body with expansion mechanism installed in pre-drilled hole using matching tolerance bit.

2. Carbon steel anchor body, washers, nuts and wedges, plated in accordance with ASTM B633, SC1, Type III or Type 304 stainless steel anchor body, washers, nuts and wedges when so indicated on plans.

PART 3 EXECUTION

3.01 VERIFICATION

- A. Inspect the locations and surfaces to receive joint filler, joint sealer, or miscellaneous embedded items and correct defects or conflicts which will affect the proper performance of the item to be placed.

3.02 PREPARATION

- A. All accessories to be embedded into concrete shall have contact surfaces free of dirt, curing compound, protrusions of hardened concrete or any other foreign material which would affect bond with concrete.
- B. Prime surfaces in accordance with manufacturer's recommendations.

3.03 INSTALLATION OF JOINT FILLERS

- A. Details, including materials and methods of installation of joint fillers shall be as indicated on the Plans and as approved by the Engineer.

3.04 INSTALLATION OF JOINT SEALANTS

- A. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degrees Fahrenheit. Bond breaker and backup material shall be installed where required as indicated on the Plans or manufacturer's recommendations.

3.05 INSTALLATION OF WATERSTOPS

- A. Waterstops shall be of maximum practicable length to minimize joints.
- B. Waterstops shall be positioned as indicated on the Plans in a manner to permanently retain flexibility.
- C. Splice in length or at intersections shall be performed by heat sealing and in accordance with manufacturer's recommendations.
- D. Reform splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. When cooled and bent by hand in as sharp an angle as possible, the splice shall show no sign of separation.
- E. Provide support and protection of the waterstops during the progress of the work. Any waterstop punctured or damaged shall be replaced or repaired at Contractor's expense. Concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.06 CONCRETE ANCHORS

- A. Do not begin installation until substrates have been properly prepared. Do not proceed with installation if substrate preparation is unsatisfactory.
- B. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Install in accordance with manufacturer's instructions and recommendations and as required by applicable code. Anchor applied items neatly, with item mounted plumb and level unless otherwise indicated.
- D. Engineer reserves the right to require the anchor manufacturer's representative to demonstrate proper installation procedures for post-installed anchors and to observe Contractor's installation

procedures, at no extra cost to Owner. Engineer reserves the right to require pullout or shear tests to determine adequacy of anchors, at no extra cost to Owner.

3.07 MISCELLANEOUS EMBEDDED ITEMS

- A. Inserts and other embedded items required for adjoining Work or for its support shall be placed prior to concreting.
- B. Embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

END OF SECTION

SECTION 03 20 00 CONCRETE REINFORCING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the furnishing, fabrication, placement and care of material used as concrete reinforcement.
- B. Latest or current ACI Standards and Code Requirements for "Concrete and Reinforced Concrete" shall govern all concrete Work except where otherwise specified herein. Copies of standards can be obtained from the American Concrete Institute.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 - Concrete Forming
- B. Section 03 15 00 - Concrete Accessories
- C. Section 03 30 00 - Cast-in-Place Concrete

1.03 ALLOWABLE TOLERANCES

- A. Fabrication
 - 1. Sheared length: ± 1 inch
 - 2. Depth of truss bars: +0, -1/2 inch
 - 3. Stirrups, ties, and spirals: $\pm 1/2$ inch
 - 4. Other bends: ± 1 inch.
- B. Placement
 - 1. Concrete cover to form surfaces: $\pm 1/4$ inch
 - 2. Minimum spacing between bars: -1/4 inch
 - 3. Top bars in slabs and beams:
 - a. Members 8 inches deep or less: $\pm 1/4$ inch
 - b. Members more than 8 inches but not 24 inches over deep: $\pm 1/2$ inch
 - c. Members more than 24 inches deep: ± 1 inch
 - 4. Crosswise of members: Spaced evenly within 2 inches of stated separation.
 - 5. Lengthwise of members: ± 2 inches
 - 6. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 1-bar diameter, with approval from the Engineer.

1.04 SOURCE QUALITY CONTROL

- A. Reinforcing steel shall be subject to inspection at the source of supply, fabricator, or after delivery to the Project Site at the discretion of the Engineer.
- B. Contractor may be required to furnish additional test of reinforcing steel for each 100 ton or fraction thereof. Testing for bend, pull, elongation and weight to assure compliance with Specifications shall be in accordance with ASTM A370.

1.05 REFERENCE STANDARDS

- A. ACI SP-66: ACI Detailing Manual
- B. ACI 301: Specifications for Concrete Construction

- C. ACI 318: Building Code Requirements for Structural Concrete and Commentary.
- D. ASTM A184/A184M: Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- E. ASTM A370: Standard Test Methods and Definitions for Mechanical Testing of Steel Products
- F. ASTM A615/A615M: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- G. ASTM A706/A706M: Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- H. ASTM A996/A996M: Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
- I. ASTM A1064/A1064M: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- J. ASTM C55: Standard Specification for Concrete Building Brick.
- K. ASTM E329: Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
- L. CRSI (DA4): Manual of Standard Practice

1.06 SUBMITTALS

- A. Contractor shall submit Shop Drawings indicating the size and dimensions for fabrication and placing of reinforcing steel, including bar schedules, stirrup spacing, and diameter of bend bars. Bar supports type and grade shall be indicated.
- B. Contractor shall submit test certificates of the manufacturer's laboratory, identifying chemical and physical analysis of each load of reinforcing steel delivered.
- C. Contractor shall submit test certificates of a qualified independent testing agency evaluation of the mechanical splice devices to assure compliance with ACI 318.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver reinforcement to Project site in bundles tagged and marked in accordance with CRSI (DA4).
- B. Reinforcing steel shall be stored above ground on platforms or other supports, in an orderly manner to facilitate inspection and checking, and be protected from physical injuries or contamination.

1.08 SEQUENCING

- A. Contractor shall coordinate placement of the reinforcing in a manner which will not prevent the proper and timely completion of dependent construction phases.

PART 2 PRODUCTS

2.01 REINFORCING BARS

- A. Reinforcement shall be of the grade and type as specified herein unless otherwise indicated on the Plans or Shop Drawing.
- B. Bars:
 - 1. Deformed and Plain Billet-Steel Bars: ASTM A615/A615M, Grade 60.
 - 2. Rail-Steel and Axle Steel Deformed and Plain Bars: ASTM A996/A996M, Grade 60.
 - 3. Low Alloy Steel Deformed Bars: ASTM A706/A706M.
- C. Mats:

1. Fabricated steel bar or rod mats of the clipped type shall conform to ASTM A184/A184M.

2.02 WELDED WIRE FABRIC

- A. Welded wire fabric shall be in flat mats only.
- B. Plain
 1. Conform to ASTM A1064/A1064M, 6 x 6 – w2.9 x w2.9 unless otherwise indicated on the Plans.
- C. Deformed
 1. Conform to ASTM A1064/A1064M, 6 x 6 – w2.9 x w2.9 unless otherwise indicated on the Plans.

2.03 TIE WIRE

- A. Plain
 1. Conform to Cold Drawn Steel Wire for Concrete Reinforcement ASTM A1064/A1064M, 16-gage minimum size.
- B. Deformed
 1. Conform to Deformed Steel Wire for Concrete Reinforcement, ASTM A1064/A1064M, size D-4 minimum.

2.04 BAR SUPPORTS

- A. Metal bar supports shall be fabricated from cold-drawn steel wire in accordance with current CRSI Standards.
- B. Stainless steel supports shall be of Type 1, with stainless steel wire conforming to ASTM A493 attached to the tips of the support so the nonstainless wire will lie no closer than 1/4 inch from the form surface.
- C. Plastic coated supports shall be of Type 1, with plastic coating of polyethylene conforming to ASTM D1248 on the legs and tips.
- D. Precast concrete brick supports shall conform to ASTM C55, Type 1, Grade N.

2.05 FABRICATION

- A. Bars shall be bent cold to the shapes and dimensions as indicated on the Plans, or as required by the current "Manual of Standard Practice" of the CRSI. Steel shall not be bent or straightened in a manner that will injure the material. Bars with kinks or improper bends shall not be used.
- B. The diameter of bend measured on the inside of the bar for standard hooks, other than stirrups and tie hooks, shall not be less than the values of the following table.

Minimum Diameters of Bend	
Bar Size	Minimum Diameter
#3 through #8	6 bar diameters
#9, #10 and #11	8 bar diameters
#14 and #18	10 bar diameters

- C. Bends for stirrups and ties with number #5 bar and smaller shall not be less than four bar diameters. For bars larger than No.#5, shall be according to the "Minimum Diameter of Bend" table above.
- D. Bends for stirrups and ties for welded wire fabric shall not be less than 4-bar diameters for deformed wire larger than D-6 and 2-bar diameters for all other wires. Bends with inside

diameter of less than 8-bar diameters shall not be less than 4-bar diameters from nearest welded intersection.

PART 3 EXECUTION

3.01 VERIFICATION

- A. Contractor shall examine the areas in which the reinforcing steel is to be placed to assure proper lines and levels.

3.02 PREPARATION

- A. Remove dirt, grease, oil, loose mill scale, excessive rust, and foreign matter that will reduce bond with concrete or splicing method.
- B. Ends of bars to be butt spliced shall be cut square and smooth.

3.03 INSTALLATION - GENERAL

- A. Reinforcing shall be placed as indicated on the approved Shop Drawings, within allowable tolerances. Bar supports, as indicated on approved Shop Drawings, or in Specifications, shall be used for proper separation and support of reinforcing steel.

3.04 MINIMUM COVER AND SPACING

- A. Unless otherwise indicated on the Plans, the minimum spacing of bars shall be the following:
- B. Footings and other principal structural members in which the concrete is deposited against the ground shall have 3 inches of concrete between the bar and the ground contact surface.
- C. Concrete surfaces which, after removal of the forms, are to be exposed to the weather or in contact with the ground or liquids, shall be protected with 2 inches of concrete.
- D. The concrete protective covering for any reinforcement at surfaces not exposed directly to the ground, liquids or weather shall be 3/4 inch for slabs and walls and 1-1/2 inches for beams and girders.
- E. Column spirals or ties shall be protected everywhere by a covering of concrete cast monolithically with the core and shall be at least 1-1/2 inches.
- F. Concrete protection for reinforcement shall in all cases be at least equal to the diameter of bars, except for concrete slabs as noted above.
- G. The minimum center to center distance between parallel bars shall be 2-1/2 times the diameter of the bars. In no case shall the clear spacing between bars be less than 1 inch nor less than 1-1/3 times the maximum size of the coarse aggregate. The maximum center to center distance in parallel bars shall be 18 inches.
- H. Where reinforcement in beams and girders is placed in two (2) or more layers, the clear distance between layers shall be not less than 1 inch, and the bars in the upper layers shall be placed directly above those in the bottom layer.
- I. Welded wire fabric designated as load-carrying reinforcement shall be overlapped wherever successive mats are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus 2 inches. It shall be supported as required for reinforcing bars.

3.05 SPLICING

- A. Splices shall be avoided at points of maximum stress. Splicing of bars shall be in accordance with ACI 318.
- B. Splicing of bars shall be done by overlapping in accordance with ACI SP-66, and securely laced with wire unless indicated otherwise on the Plans or approved Shop Drawing.

- C. Lap adjoining wire mesh by no less than one (1) full mesh and lace securely with wire. Offset end laps in adjacent widths to prevent continuous splice.
- D. Welded wire fabric reinforcement shall be overlapped wherever successive mats are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than one full mesh spacing plus 2 inches. The fabric shall extend across supporting beams and walls and to within four 4 inches of concrete edges. It may extend through contraction joints where alternate wires are field cut. It shall be adequately supported during placing of concrete to ensure its proper position in the slab either by the methods of Part 3 of this Section or by laying the fabric on a layer of the fresh concrete of the correct depth before placing the upper layer of the slab.
- E. Vertical bars in columns shall be offset at least 1-bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.
- F. Bars of size #14 and #18 or larger, where size #11 bars are butt spliced to larger sizes and/or when approved by the Engineer shall be welded in accordance with ACI 301 by full penetration butt welds. Adequate jigs and clamps or other devices shall be provided by the Contractor to support, align and hold the longitudinal centerline of the bars in a straight line.
- G. Bars larger than #11 may be butt spliced by mechanical devices approved by the Engineer, in accordance with ACI 318. Splices shall be made using manufacturer's standard jigs, clamps, ignition devices and other required accessories to support, align and hold the longitudinal centerline of the bars in a straight line.

3.06 SECURING REINFORCEMENT

- A. Reinforcement shall be securely laced with wire to supports or reinforcing to prevent displacement during the concrete placement, as required by the current CRSI (DA4).

3.07 FIELD QUALITY CONTROL

- A. Engineer shall inspect the reinforcing steel after it has been installed, and the reinforcing steel placement shall be approved by the Engineer prior to placement of concrete.
- B. Contractor shall avoid displacement of the reinforcing steel during concrete placement.

END OF SECTION

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes all monolithic cast-in-place concrete work complete with materials, mixes, installation and testing.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 03 15 00 - Concrete Accessories
- C. Section 03 20 00 - Concrete Reinforcing
- D. Section 03 60 00 - Grouting
- E. Section 05 12 00 - Structural Steel Framing
- F. Section 07 10 00 - Dampproofing and Waterproofing
- G. Section 31 23 19 - Dewatering

1.03 REFERENCE STANDARDS

- A. ACI 312.3R: Report on Chemical Admixtures for Concrete
- B. ACI 301: Specifications for Concrete Construction
- C. ACI 304R: Guide for Measuring, Mixing, Transporting, and Placing Concrete
- D. ACI 305R: Guide to Hot Weather Concreting
- E. ACI 306R: Guide to Cold Weather Concreting
- F. ACI 318: Building Code Requirements for Structural Concrete (ACI 318-19) Commentary on Building Code Requirements for Structural Concrete
- G. ASTM C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- H. ASTM C31/C31M: Standard Practice for Making and Curing Concrete Test Specimens in the Field
- I. ASTM C39/C39M: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- J. ASTM C94/C94M: Standard Specification for Ready-Mixed Concrete
- K. ASTM C143/C143M: Standard Test Method for Slump of Hydraulic-Cement Concrete
- L. ASTM C150/C150M: Standard Specification for Portland Cement
- M. ASTM C172/C172M: Standard Practice for Sampling Freshly Mixed Concrete
- N. ASTM C183: Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
- O. ASTM C231: Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
- P. ASTM C260/C260M: Standard Specification for Air-Entraining Admixtures for Concrete
- Q. ASTM C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- R. ASTM C494/C494M: Standard Specification for Chemical Admixtures for Concrete

- S. ASTM C595/C595M: Standard Specification for Blended Hydraulic Cements
- T. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- U. ASTM C989/C989M: Standard Specification for Slag Cement for Use in Concrete and Mortars
- V. ASTM D75 / D75M - 19 Standard Practice for Sampling Aggregates

1.04 REFERENCE SPECIFICATIONS

- A. The latest or current ACI Standards and Code Requirements for "Concrete and Reinforced Concrete" shall govern all concrete Work except where otherwise specified herein.
- B. Michigan Department of Transportation, Standard Specifications for Construction, latest edition (MDOT)

1.05 TESTING AGENCY

- A. Inspections and tests required by this Section shall be performed by organizations acceptable to the Engineer.

1.06 ALLOWABLE TOLERANCES

- A. See Section 03 11 00 for the allowable tolerances for concrete surfaces.

1.07 DESIGN CRITERIA

- A. Mixes shall be designed and tested for each size and gradation of aggregates and for each consistency intended for use. Design quantities and test results of each mix shall be submitted for review.
- B. Necessary construction joints are shown on the Plans. Modification of location or placement of construction joints not indicated on the Plans shall be subject to approval of the Engineer. In general, they shall be located within the middle one-third of the span of slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam.
- C. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs. 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.
- D. Expansion joint locations and details shall be as shown on the Plans. In no case shall any fixed metal be continuous through a expansion joint.
- E. Keyways shall be provided in all joints where required to provide for either shear or watertightness. Unless otherwise required, the width of keys shall be at least one-third the thickness of the section at that point and their depth at least one-third their width.

1.08 SOURCE QUALITY CONTROL

- A. Furnish tests of cement and aggregates. Material sampling shall conform to the following ASTM Standards:
 - 1. Cement C183
 - 2. Aggregates D75.
- B. Testing shall be in accordance with applicable ASTM Standards to assure compliance with Specifications.
- C. Make tests for the following quantities, or fraction thereof:
 - 1. Cement: 550 tons
 - 2. Fine Aggregate: 2,000 tons

- 3. Coarse Aggregate: 2,000 tons
- D. Use same brand cement for any given structure produced by a single mill unless otherwise provided by authorization of the Engineer.

1.09 SUBMITTALS

- A. Submit Shop Drawings showing the location of joints. Included shall be a schedule of the concrete pouring. The location of joints and pouring schedule shall be subject to approval by the Engineer.
- B. Contractor shall submit test reports for cement and aggregates to assure compliance with the Specifications.
- C. Concrete mixture designs and test data shall be submitted for review by the Engineer with a written request for approval. No concrete shall be placed until the Contractor has received such approval in writing.
- D. Each mixture report shall include:
 - 1. Slump on which design is based.
 - 2. Total gallons of water per cubic yard (l/m³).
 - 3. Brand, type, composition, and quantity of cement.
 - 4. Brand, type, composition, and quantity of pozzolan or other mineral admixtures.
 - 5. Brand, type, composition, and quantity of ground granulated blast furnace slag.
 - 6. Specific gravity and gradation of each aggregate.
 - 7. Ratio of fine to total aggregates.
 - 8. Weight (surface dry) of each aggregate, lbs./c.y. (kg/m³).
 - 9. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
 - 10. Air content.
 - 11. Compressive strength based on 7-day and 28-day compression tests.
 - 12. Time of initial set.
- E. Submit manufacturer's literature of abrasive wear resistant floor finish and of chemical curing compound for review by the Engineer.
- F. Submit a sample concrete delivery ticket for review by the Engineer.
- G. Submit tickets collected at the site of concrete placement accompanying each load of concrete. A printout system for producing these tickets in connection with automatic batching will be permitted.
 - 1. Each ticket shall be serially numbered, show the charging time, quantity and grade of concrete, location of delivery and the signatures of inspectors at the plant and site. Transit mixed concrete tickets shall also include revolution counter reading at charging and mixing completion.
- H. Submit reports of the sampling and testing of slump, air content and strength performed.
- I. Submit reports of nondestructive, core and/or liquid retention testing required for acceptance of concrete in place.

1.10 MATERIAL STORAGE AND HANDLING

- A. Materials shall be stored and handled in accordance with ACI 304R and as specified below.

- B. When permission is given to store cement in the open, a floor at least 6 inches above the ground and a waterproof covering shall be provided and so placed as to insure runoff in case of rain.
- C. Cement sacks shall be thoroughly shaken when emptying sacks into the batch. Cement salvaged by the Contractor by cleaning sacks mechanically or otherwise, or from discarded sacks of cement, shall not be used in the Work. The use of a fractional sack of cement will not be permitted unless the fractional part is measured by weight. At the time of its use in the Work, the cement shall be free from lumps.
- D. No aggregates which have become intermixed prior to proportioning shall be used. Sufficient aggregate shall be available at the site to preclude the possibility of damaging delays while placing the concrete.
- E. Cars used for shipping aggregates shall be clean and in good repair. The use of straw, marsh, hay or other similar materials for closing cracks or holes in cars will not be tolerated.
- F. Pozzolans and other cementitious materials shall be stored and handled in the manner of cement.
- G. Store and handle curing compound in a manner to prevent contamination.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Environmental requirements shall be in accordance with ACI 305R for hot weather concreting, and ACI 306R for cold weather concreting.
- B. Specific temperature requirements are contained in Part 2 of this Section for mixing and Part 3 of this Section for placing.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

- A. The materials shall meet the requirements of ACI 301, ACI 318, and MDOT Specification, Division 9.
- B. Concrete materials shall be tested and inspected as the Work progresses. The review and/or check-test of the proposed materials, securing of production samples of materials at plant stockpiles and/or review of the manufacturer's reports for compliance will be performed at no cost to the Contractor.
- C. Testing and inspection required due to substitution or change of materials requested by the Contractor shall be at the Contractor's expense.

2.02 CEMENT

- A. Cement shall be the type as indicated on the Plans or as specified.
 - 1. Type I and IA, conforming to ASTM C150/C150M, air-entraining Portland cement when special properties are not specified.
 - 2. Type III and IIIA, conforming to ASTM C150/C150M, air-entraining Portland cement for use when high-early strength is specified.
 - 3. Type IS and IS-A, conforming to ASTM C595/C595M, air-entraining Portland blast-furnace slag cement for use in general concrete construction.
 - 4. Type IP and IP-A, conforming to ASTM C595/C595M, air-entraining Portland-Pozzolan cement for use in general construction. The addition of suffix (MS) signifies that moderate sulfate resistance is specified. The addition of suffix (MH) signifies that moderate heat of hydration is specified.

2.03 AGGREGATES

- A. Washing will be required to eliminate the dust, clay, or silt coating. Aggregates which have been washed shall not be used sooner than 24 hours after washing, unless approved by the Engineer.
- B. Coarse aggregate shall be gravel or crushed rock, conforming to MDOT Section 902.03. Class 17A for members 8 inches or less in thickness and Class 6AA for other construction.
 - 1. Gravel shall consist of hard, clean, durable particles of rock or pebbles and shall be free from lumps of clay.
 - 2. Crushed rock shall consist of angular fragments of crushed hard heads or boulders or crushed igneous rock free from weathered rock and of uniform quality.
 - 3. All sieve and screen analyses determination of clay, silt, and dust content and percentages of objectionable particles will be based on dry weights and conform to MDOT Section 902.03, Table 902-1, "Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open Graded Aggregates" and Table 902-2, "Physical Requirements for Coarse Aggregate, Dense Graded Aggregates and Open Graded Aggregates."
- C. Fine aggregate shall be sand size 2NS, MDOT, Section 902.08.
 - 1. Fine aggregates shall consist of sharp sand which shall be composed of clean, hard, durable grains and shall be free from lumps of clay and organic deleterious substances.
 - 2. Fine aggregates shall conform to MDOT Section 902.09 and Table 902-4, "Grading Requirements for Fine Aggregates."

2.04 ADMIXTURES

- A. Admixtures shall be used to achieve concrete as indicated on the Plans or specified herein. Calcium chloride shall not be used.
 - 1. Air-entraining, conforming to ASTM C260/C260M.
 - 2. Pozzolan and Fly Ash, conforming to ASTM C618, Class F.
 - 3. Water reducing, conforming to ASTM C494/C494M.
 - 4. Retarder, conforming to ASTM C494/C494M.
 - 5. Plasticizer, conforming to ASTM C494/C494M.
 - 6. Ground granulated blast furnace slag conforming to ASTM C989/C989M, grade 100.
- B. Abrasive wear resistant floor finish shall be packaged, dry combination of Portland cement, graded Quartz aggregate and dispersing agents formulated to produce an abrasive and wear resistant monolithic surface.

2.05 JOINT FILLER

- A. See Section 03 15 00.

2.06 WATER

- A. Water shall be free from oil, acid, alkali, organic matter, and any other deleterious substances. Water approved by the Local Board of Health may be used without testing. Water from other sources shall be tested before using.

2.07 CURING COMPOUND

- A. Shall be adequate to prevent checking, cracking and loss of moisture, conforming to ASTM C309.

2.08 MIXES

- A. Concrete shall consist of a mixture of air-entraining Portland cement, coarse and fine aggregate, Class F Fly Ash, and water with admixtures if required. Admixtures shall not be used without the Engineer's review.
- B. The mixture, combined in proportions, shall meet the requirements of MDOT, Specification Section 701, and ACI 211.1.
- C. Concrete shall be classified and proportioned on the basis of minimum compressive strength at 28 days when cured in a moist room at a temperature within the range of 68 - 75 degrees F. The desired strength of the concrete shall be shown on either the Plans or in the Specifications.
- D. Table 1 shows for each grade of concrete the minimum compressive strength, cement content, and the modulus of rupture. Concrete shall be 3,500 psi, unless otherwise shown on the plans.

Table 1 - Concrete Mixtures						
Concrete Grade	Coarse Agg	Type of Cement	Cement Content	Min Compressive Strength @ 28 days	Min Modulus of Rupture @ 28 days	% Air
4500 psi	6AA	I, IA, IS, IS-A	658 lbs/cyd	4500 psi	725 psi	4 - 6
4000 psi	6AA or 17A	I, IA, IS, IS-A	611 lbs/cyd	4000 psi	700 psi	4 - 6
3500 psi	6AA or 17A	IS, IS-A, IP, IP-A	564 lbs/cyd	3500 psi	650 psi	4 - 6

- 1. Maximum water cement ration shall be 0.45.
- 2. Structural concrete for walls and slabs shall be placed with a slump of 4 inches maximum.
- 3. Ground granulated blast furnace slag (GGBFS) may be substituted for cement on a pound for pound basis from a minimum of 25% up to a maximum of 40% GGBFS and 60% cement.
- 4. Minimum fly ash content in the mix shall be 25%, additional fly ash may be substituted for cement on a pound for pound basis up to a maximum of 40% fly ash and 60% cement when approved by the Engineer.
- 5. Maximum total replacement of cement shall not exceed 40%.
- E. Aggregates shall be proportioned by weight, except for small structures and for incidental Work requiring less than 10 cubic yards of concrete, in which case they may be proportioned by volume when approved by the Engineer.
- F. Cement in bulk, when permitted, shall be proportioned by weight.
- G. When proportioned by volume, the amount of each aggregate required for a single batch shall be measured separately and accurately. Shovel methods of measuring will not be permitted. The unit of volumetric measurement shall be 1 cubic yard.
- H. When proportioned by weight, the amount of each aggregate required for a single batch shall be weighed in a separate container. The equipment for weighing shall be of an approved type, and of such accuracy that there shall not be an error of more than one (1) percent in any one (1) batch.

2.09 BATCHING ADMIXTURES

- A. The batching of admixtures to achieve and maintain production of the mix design of concrete shall be in accordance with ACI 212.3R.

- B. If the air content is found to be less or greater than the specified amount, the Contractor shall immediately discontinue Work and correct the air content.
- C. Decreasing the air content may be accomplished by blending air-entraining Portland cement with Portland cement, manufactured at the same mill, in a ratio which will reduce the air content to a value within the specified limits, this blending shall be reviewed by the Engineer.
- D. Increasing the air content may be accomplished by adding to each batch a sufficient amount of air-entraining admixture to bring the air content up to the designed amount.
- E. Pozzolan and ground granulated blast furnace slag shall be proportioned based on the mix design approved by the Engineer to produce watertight concrete.
- F. Water Reducer can be used to reduce the water requirement of concrete to obtain consistency of slump, modify workability, increase strength or any other approved use.

2.10 TEMPERATURE LIMITS OF MIXTURE

- A. The temperature of the cement, at the time of delivery to the mixer, shall not exceed 165 degrees F. The cement shall be stored at the Contractor's expense until cooled to that temperature.
- B. The temperature limits of aggregates and water entering the mixer shall be as follows:

Component	Minimum	Maximum
Water	75°F (24°C)	140°F (60°C)
Fine Aggregate	65°F (18°C)	140°F (60°C)
Coarse Aggregate	65°F (18°C)	110°F (43°C)
Concrete (resulting)	60°F (15°C)	90°F (32°C)

2.11 MIXERS AND MIXING

- A. Concrete mixing operations shall be in accordance with ACI 304 and MDOT, Section 701, and shall be subject to random inspection during the progress of the Work at no charge to the Contractor.
- B. Central Mixed Concrete:
 - 1. Mixers shall be capable of quickly and completely discharging without segregation or loss.
 - 2. Efficiency of the mixers shall be maintained at all times through repair or replacement of worn parts when necessary.
 - 3. Mixers shall be provided with readily adjustable, automatic devices which will measure the cement and water within one (1) percent and admixtures within three (3) percent.
 - 4. The drum of the mixer shall be kept free from hardened concrete and shall be completely emptied before recharging.
 - 5. Retempering or remixing concrete that has partially set will not be permitted.
 - 6. Mixer shall be cleaned thoroughly each time when out of operation for more than 1/2 hour.
 - 7. Recommended mixing time is a minimum time of 1 cubic yard, with an additional 15 seconds for each additional 1 cubic yard.
 - 8. Concrete shall be delivered to the site in clean, tight truck bodies designed for this purpose and painted with paraffin if necessary for easy dumping.
 - 9. The concrete at the point of delivery shall have the proper consistency and shall be free from segregation.
 - 10. Mechanical agitators in the truck bodies will be required if the period of time from the mixing plant to the point of dumping exceeds 30 minutes.

11. No concrete shall be dumped if the elapsed time from the mixing plant to the point of dumping exceeds 60 minutes.

C. Transit Mixed Concrete:

1. Transit-mix concrete shall be in accordance with ASTM C94/C94M. If transit-mix concrete is used, it shall meet all the foregoing requirements specified for central mixed concrete and, in addition, the following:
 - a. The batched materials shall be properly proportioned and in a dry state. The proper amount of water shall be added to the mixer on the trucks, and no additional water shall be added. No admixtures or accelerators shall be added except as herein noted, without the approval of the Engineer.
 - b. Trucks shall not be loaded beyond their rated capacity and shall have mixing drums cleaned of all set-up materials at frequent intervals while in use. Trucks with leaking water valves shall not be used.
 - c. Recommended mixing speed should be no less than 12 revolutions per minute, with a minimum of 90 revolutions or until the mix is satisfactory.
 - d. Mixing shall be continuous after water is added to the mix in the drum, but no concrete shall be placed in the forms more than 90 minutes after water is added to the mix.
 - e. Truck-mixed concrete shall be delivered to the site of the Work and discharged from the mixer within the maximum period of 1-1/2 hours from the first introduction of water to the mix. Any concrete which remains in the mixer after this period and any concrete which appears too stiff to be properly workable or which appears to have begun to take its initial set shall be rejected and removed from the site of the Work.

- D. Owner may employ an independent testing laboratory to provide a qualified inspector to be present at the plant where batching of concrete occurs. The inspector shall verify the compliance of the mix with the Specifications and shall sign a form indicating the quantity of concrete and the concrete mixture of each load.

2.12 CHANGE OF MIXTURE

- A. If Contractor requests a change or substitution of approved batch proportioning, mixing, or delivery operations additional testing and/or inspection shall be at Contractor's expense.

2.13 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers of abrasive wear resistant floor finish include: Master Builders Company "Mastercon Aggregate," Sonneborn Building Products "Harcot," or equal.

PART 3 EXECUTION

3.01 VERIFICATION OF FORMWORK, REINFORCING, AND SUBGRADES

- A. Contractor shall inspect formwork, reinforcement and subgrades to confirm compliance with the related Work specified elsewhere.

3.02 EMBEDDED ITEMS

- A. Contractor shall verify the location, from certified vendor or applicable engineering drawings, of all embedded items including anchor bolts, wall sleeves, wall casting, railing post sleeves and miscellaneous pipes and conduits and shall install the items accurately at the locations determined.

3.03 BUILDING IN OTHER WORK

- A. Contractor shall make all necessary provisions in concrete Work for other Work installed by this or other contractors, and build in all required steel beams, frames, curbs, expansion joints, inserts, hangers, pipes, floor drains, pipe trench covers and frames, anchors, sleeves, floor

ducts, fiber and steel conduit, pipe hanger sockets, and all other Work furnished by either this or other contractors.

- B. Contractor shall build in all anchors, ties, etc., specified under brick and other Work, in faces of concrete Work which are to be faced with masonry, and any other Work shown or noted to be built into concrete. In addition, Contractor shall provide all openings and holes in concrete Work as shown or as needed to accommodate other Work.

3.04 SPECIAL CONCRETE

- A. Contractor shall verify the use and/or locations of watertight concrete and/or high-early strength concrete.

3.05 PREPARATION

- A. Contractor shall notify the Engineer two (2) working days prior to placement of concrete.
- B. Before depositing new concrete on or against existing concrete the existing concrete shall be roughened, thoroughly cleaned of foreign matter and laitance and saturated with water. The cleaned and saturated surface of the hardened concrete, including vertical and inclined surfaces, shall be coated with a bonding agent or slushed with a minimum 2 inch thick coating of concrete without coarse aggregate grout against which the new concrete shall be placed before the mixture has attained its initial set.
- C. Before concrete is placed in any unit, the forms and the placing and fixing of all steel and incidental items shall be complete, and the forms, steel and adjacent concrete shall be thoroughly cleaned and wetted down.
- D. Where indicated on the Plans, the Contractor shall bridge the subgrade with at least 2000 psi, 3 inch thick lean concrete before placing the reinforcement. This shall be at no extra cost.
- E. No concrete shall be deposited in any unit until the area has been completely dewatered in accordance with Section 31 23 19, and not until after the Contractor has made satisfactory provisions to eliminate all possibility of water entering or flowing through the concrete while it is being poured or is taking its set. No concrete shall be placed under or on water.

3.06 CONVEYING

- A. Concrete handling equipment shall be of such a nature and shall be so located that the concrete after leaving the mixer will reach its destination with a minimum lapse of time, with no segregation, and loss of slump. The use of drop chutes, except at or in the forms, is prohibited.
- B. The interior hopper slope of concrete buckets shall be not less than 60 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five (5) times the nominal maximum size aggregate and the area of the gate opening shall be not less than 2 square feet.
 - 1. Maximum dimension shall not be greater than twice the minimum dimension.
 - 2. Bucket gates shall be essentially grout tight when closed and may be manually, pneumatically or hydraulically operated except for buckets larger than 2 cubic yards shall not be manually operated.
 - 3. Design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.
- C. Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing.
- D. Concrete may be conveyed by positive displacement pump when authorized by the Engineer. The pumping equipment shall be piston or squeeze pressure type. The pipeline shall be rigid steel pipe or heavy duty flexible rubber hose. The inside diameter of the pipe shall be at least

three (3) times the nominal maximum size coarse aggregate in the concrete mixture to be pumped. The maximum size coarse aggregate shall not be reduced to accommodate the pumps.

- E. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

3.07 PLACING

- A. Concrete shall be so deposited as to maintain the top surface level, unless otherwise shown on the Plans, and also as to avoid any appreciable flow in the mass.
- B. Where placing operations involve dropping the concrete more than 3 feet in the forms, it shall be deposited through sheet metal or other approved spouts or pipes. These spouts or pipes shall have suitable receiving hoppers at the upper ends, and the lower ends shall be kept within 6 inch of the newly placed concrete so as to prevent segregation and avoid spattering the reinforcing steel with mortar. Under no circumstances shall concrete that has partly hardened be deposited in the Work.
- C. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet per hour. Concrete vibrators shall penetrate the initial layer when placing the following layer. Vertical construction joints shall be provided as necessary to comply with these requirements.
- D. Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet of vertical height. Concrete in walls or columns shall set at least two (2) hours before concrete is placed in the structural systems to be supported by such walls or columns.
- E. Concrete shall be set when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.
- F. No concrete shall be placed in contact with frozen ground. Time between charging and placement of concrete shall not exceed 1-1/2 hours.
- G. Concrete shall be compacted by continuous vibrating, tamping, spading or slicing. Care shall be taken to eliminate all voids and to provide full bond on reinforcing steel and embedded fixtures. Mechanical vibration shall be employed. Concrete shall be compacted and thoroughly worked with suitable tools combined with the use of vibrators applied internally and providing a frequency not less than 7,000 revolutions per minute. All such vibrating, including the methods and equipment, shall be subject to the review of the Engineer.
- H. The time of vibrating in any area shall only be sufficient to get efficient compaction, but shall in no case be carried to the point where there is segregation of the fine and coarse materials of the mix. There shall be an absolute minimum of direct vibration of the steel or forms during the process of vibrating. Vibrators shall be inserted and withdrawn from the concrete at numerous locations, from 18 - 30 inches apart, but shall not be used to transport concrete within the forms. Contractor shall have a stand by vibrator on the job site during all concrete pouring operations.

3.08 FINISHING UNFORMED SURFACES

- A. The unformed surfaces of all concrete shall be screeded and given an initial float finish followed by steel troweling.

- B. Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch as measured from a 10 foot straightedge.
- C. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface. Floating shall be performed with hand floats or suitable mechanical compactor floats.
- D. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks. The top surface of driveways, and sidewalks shall be given a broomed finish after troweling.
- E. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having 1/4 inch corner radius.

3.09 FINISHING FORMED SURFACES

- A. After removal of forms, the finishing of all concrete surfaces shall be started as soon as its condition will permit.
- B. Grind all seams, fins or projections flush with the concrete surface.
- C. Fill and point all honeycomb, tie holes and voids.
- D. Dampen the surface with water and apply a cement and silica sand slurry to the entire surface to fill small defects and air voids.
- E. Remove excess slurry from concrete. Surfaces to be finished shall receive an application of dry Portland cement which shall be rubbed into the slightly dampened surface with a suitable cloth.
- F. After pointing and removal of projections as specified herein, exposed surfaces of concrete, including walls, columns, beams, pilasters and the undersides of slabs, shall be given a rubbed surface finish.

3.10 FLOORS

- A. Concrete floor finish shall be applied to all building floors not receiving further floor finish. At these locations, the concrete shall be brought to the proper elevation and screeded. The surface shall be given two (2) steel trowelings when the concrete has set sufficiently to finish smoothly. Floors shall be sloped uniformly toward floor drains at a slope of 1/8 inch per foot.
- B. The concrete finish on steps and loading platforms shall be wood troweled to true and uniform surface and then steel troweled. The surface shall then be slightly roughened with a broom or by dragging burlap across the surface.
- C. Concrete floors shall be finished with an abrasive resistant floor finish in the areas noted on the finish schedule on the Plans. Premixed floor hardener shall be applied to the surface of the freshly floated concrete floor, in strict accordance with the manufacturer's directions. Color to be selected by the Owner.

3.11 EXPANSION JOINTS

- A. Comply with the requirements of Section 03 15 00. Expansion joints shall have removable polystyrene joint caps secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces.
- B. Joint caps shall be of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant to the size shown on the Plans.

- C. Joint caps shall not be removed until after the concrete curing period.

3.12 CONCRETE CURING

- A. Concrete shall be cured for a period not less than seven (7) consecutive days. Contractor shall have adequate equipment and curing material on the job site before concrete placement begins, and it shall be adequate to prevent checking and cracking and loss of moisture from all the surfaces of the concrete. The concrete shall be protected from rain, flowing water, wind and the direct rays of the sun. Openings in concrete shall be sealed to prevent drying of the concrete during the curing period.
- B. Curing compounds shall not be used on surfaces to which additional concrete or other material are to be bonded.
- C. Curing compounds when used shall be applied in strict accordance with the manufacturer's recommendations.
- D. Concrete cured with water shall be kept wet by covering with ponded water or fog spraying to keep all surfaces continuously wet.
- E. Horizontal construction joints and finished surfaces cured with sand shall be covered a minimum thickness of 1 inch, uniformly, and kept saturated during the curing period.
- F. Burlap used for curing shall be treated to resist rot and fire and free of sizing or any substances that are injurious to Portland cement or cause discoloration. Strips shall be lapped by half widths. The burlap shall be saturated with water after placement and during the curing period.
- G. Straw or hay shall be in a layer no less than 6 inch thick and held in place by screens, wire or other means to prevent dispersion by the wind. Care shall be observed to avoid discoloration of the concrete surface from the vegetable fibers and for the flammability of the material. The straw shall be saturated with water after placement and during the curing period.

3.13 ENVIRONMENTAL CONDITIONS

- A. Contractor shall provide cold or hot weather protection in accordance with ACI and as specified herein. There shall be no additional cost for hot or cold weather protection of the concrete.
- B. Cold Weather Protection:
 - 1. When placing concrete in cold weather, the Contractor shall plan and prosecute his Work in a manner which shall assure results free from damage through freezing, contraction, and loss of concrete strength.
 - 2. No concrete shall be poured when the surrounding temperature is below 40 degrees F, unless the aggregates and water are properly heated. Concrete which has been poured at higher temperatures but has not attained a strength equal to 75% of the required strength of the class of concrete involved, shall be housed and protected in accordance with the provisions of this Section whenever the surrounding temperature falls below 40 degrees F.
 - 3. Application of heat to the materials shall be made in a manner which will keep these materials clean and free from injurious substances.
 - 4. Aggregates may be heated only by steam coils or steam jets, except in the case of small quantities of concrete when other methods may be approved by the Engineer. A sufficient quantity of properly heated aggregates shall be on hand prior to starting the pouring of any unit.
 - 5. Concrete shall be properly housed with canvas, burlap, or other windproof material in such a manner that any necessary removal of the forms or finishing of the concrete can proceed without undue damage to the concrete from the elements. Heating of the housing shall be done in a manner which will maintain a temperature between 50 - 70 degrees F, at all times for at least five (5) days after the pour is complete and 12 hours before the

pour begins. All supplemental heating units shall have exhaust vented to the exterior and shall not cause deleterious reactions or deposits to occur to concrete.

C. Hot Weather Protection:

1. Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90 degrees F.
2. In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays, or other devices shall be provided.

3.14 ADDITION OF WATER

- A. To increase workability, adding water to the mix shall be limited to a one time addition of 1 gallon per cubic yard and mixed with a minimum of 30 revolutions at a rate of 12 to 15 revolutions per minute. Addition of water shall be within the slump requirements.

3.15 CONCRETE DELIVERY TICKET

- A. A ticket system shall be used for recording the transportation of concrete from the batching plant to point of delivery. This ticket shall be issued to the truck operator at the point of loading and given to the Engineer upon delivery. The ticket shall as a minimum indicate the time of mixer charging, quantity of concrete, type of mixture including amount of cement, and the plant where the concrete was batched.

3.16 CONCRETE DELIVERY REJECTION

- A. Concrete not permitted for inclusion in the Work by the Engineer shall be removed from the site. Rejection of concrete will be determined through concrete testing and elapsed time from mixer charging to delivery.

3.17 CONCRETE TESTING AT PLACEMENT

- A. Tests shall be made of fresh concrete for each 50 cubic yards, or whenever consistency appears to vary. The sampling and testing of slump, air content and strength will be performed at no cost to the Contractor.
- B. Composite samples shall be secured in accordance with the Method of Sampling Fresh Concrete, ASTM C172/C172M.
- C. Slump Test:
1. Slump Test shall be in accordance with ASTM C143/C143M. Contractor shall use the least slump possible consistent with workability for proper placing of the various classifications of concrete.
 2. A tolerance of up to 1 inch above the indicated maximum slump shall be allowed for individual batches provided the average for all batches or the most recent ten (10) batches tested, whichever is fewer, does not exceed the maximum limit.
- D. Air Content:
1. Air content of normal weight concrete will be determined in accordance with ASTM C231, Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
- E. Compressive Strength:
1. A set of cylinders for compressive strength tests will consist of four cylinders per each set. The temperature of concrete sample will be determined for each strength test.
 2. Molding and curing specimens from each set shall be in accordance with ASTM C31/C31M. Any deviations from the requirements of this Standard shall be recorded in the test report.

3. Testing specimens will be in accordance with ASTM C39/C39M. One (1) specimen shall be tested at seven (7) days for information and two (2) shall be tested at 28 days for acceptance.
 - a. Acceptance test results shall be the average of the strengths of the two (2) specimens tested at 28 days. If one (1) specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result.
4. The strength level of the concrete will be considered satisfactory so long as the averages of all 28-day strength test results equal or exceed the specified 28-day strength and no individual strength test result falls below the specified 28-day strength by more than 500 psi.
5. If the strength test is not acceptable, further testing shall be performed to qualify the concrete.

3.18 TESTING OF CONCRETE IN PLACE

- A. Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements shall be at the expense of the Contractor.
- B. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.
- C. When required by the Engineer, cores at least 2 inch in diameter shall be obtained and tested in accordance with ASTM C42.
 1. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60° to 80°Fahrenheit (15°to 25°Celsius), relative humidity less than 60%) for 7 days before test and shall be tested dry.
 2. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C42.
- D. At least three (3) representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Engineer so as to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced.
- E. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85% of and if no single core is less than 75% of the specified 28-day strength.
- F. Core holes shall be filled by low slump concrete or mortar.

3.19 RETENTION TESTING

- A. Tanks or structures designed to hold or retain water, wastewater or other liquids shall be retention tested.
- B. To test a tank or structure for leakage, the Contractor shall clean, disinfect (if required) and fill the tank or structure with water to its maximum level.
- C. The water shall be allowed to remain 24 hours with all associated valves and appurtenances tightly closed.
- D. During this 24-hour period, the water level as measured by a hook gage shall show no measurable loss.

- E. If this test fails, the Contractor shall dewater the tank or structure, make such repairs as necessary to achieve a watertight tank or structure, clean, disinfect (if required), and retest.
- F. Tests and repairs shall be repeated until the tank or structure is accepted by the Engineer.

3.20 DEFECTIVE CONCRETE

- A. If, in the opinion of the Engineer, the defects in the concrete are of such a nature as to warrant condemnation, that portion of the pour may be ordered replaced in its entirety and the Contractor shall promptly replace same without additional compensation.
- B. Defective concrete shall be repaired by cutting out the defective area and placing new concrete which shall be formed with keys, dovetails or anchors to attach it securely in place.

END OF SECTION

SECTION 03 41 00 PRECAST CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes precast structural concrete as indicated on the Plans complete with product design, manufacture, transportation, erection, and other related items such as anchorage, bearing pads, storage and protection.

1.02 RELATED WORK SECTIONS

- A. Section 03 20 00 - Concrete Reinforcing
- B. Section 03 60 00 - Grouting

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AASHTO - American Association of State Highway and Transportation Officials
 - 2. ACI - American Concrete Institute
 - 3. AWS - American Welding Society
 - 4. ASTM- American Society for Testing and Materials
 - 5. PCI - Precast and Prestressed Concrete Institute

1.04 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in providing precast concrete products and services normally associated with the industry for at least five (5) years. When requested by the Engineer, submit written evidence to show experience, qualifications and adequacy of plant capability and facilities for performance of Contract requirements.
- B. Erector shall be regularly engaged for at least five (5) years in the erection of precast structural concrete similar to the requirements of this Project.
- C. Welders shall have qualified within the past year in accordance with AWS D 1.1.

1.05 DESIGN CRITERIA

- A. Submit design calculations by a registered professional engineer, registered in the state where the Work is located, experienced in precast concrete design.
- B. Use in the design, applicable codes, ACI 318, or AASHTO Standard Specifications for Highway Bridges. Include in the design loads: all dead and live loads as indicated on the Plans, initial handling and erection stresses, and all other loads specified for members where they are applicable.
- C. Watertight Precast reinforced concrete structures shall be designed in accordance with ASTM C890, for A-16(HL-93) loading and installation conditions.

1.06 REFERENCE SPECIFICATIONS

- A. All local codes plus the following Specifications, standards and codes are a part of these Specifications:
 - 1. ACI 318 -Building Code Requirements for Reinforced Concrete.
 - 2. AWS D1.1 -Structural Welding Code.
 - 3. AWS D1.4 -Reinforcing Steel Welding Code.

4. AASHTO Standard Specifications for Highway Bridges.

1.07 ALLOWABLE TOLERANCES

- A. Design deviations may be permitted only after the Engineer's review of the manufacturer's proposed design supported by complete design calculations and drawings.
- B. Provide an installation equivalent to the basic intent of the Work without incurring additional cost to the OWNER.
 1. Length: +/- 1/8 inch per 10 feet (1 mm per meter), +/- 1/4 inch (5 mm) maximum
 2. Cross sectional dimensions:
 - a. Less than 24 inches (600 mm) +/- 1/4 inch, (5 mm) 24 to 36 inches (600 to 900 mm): +/- 3/8 inch (9 mm)
 - b. Over 36 inches (900 mm): +/- 1/2 inch (10 mm)
 3. Thickness: +/- 1/4 inch (5 mm)
 4. Position of anchors and inserts: +/- 1/2 inch (10 mm) of centerline location shown on the Plans.
 5. Horizontal alignment or sweep: 1/4 inch (5 mm) total or 1/8 inch per to-foot length (1 mm per meter), whichever is greater. Maximum of 1/2 inch (10 mm) gap between two (2) adjacent members due to sweep.
 6. End squareness: 3/8 inch (9 mm) maximum
 7. Blockouts: +/- 1/2 inch (10 mm) off centerline locations shown on the Plans.
 8. Out of square: 1/8 inch per six (6) feet (5 mm per 3 m) measured on the diagonal.
 9. Warpage, after installation: 1/8 inch per 6-foot (5mm per 3 m) length, or 3/8 inch (9 mm), whichever is greater.
- C. Vertical alignment:
 - a. Bottom edges of members from line established at lower face: +/- 1/4 inch (5 mm).
 - b. Bottom surface from straight line between supports: 1/240 of clear span.

1.08 SOURCE QUALITY CONTROL

- A. Comply generally with applicable provisions of Prestressed Concrete Institute MNL-116, Manual for Quality Control for Plants and Production of Precast, Concrete Products.

1.09 SUBMITTALS

- A. Contractor shall submit design calculations of products not completed and/or indicated on the Plans in accordance with the provisions of this Section.
- B. Submit erection or production drawings showing:
 1. Drawings and/or elevations locating and defining all material furnished by manufacturer.
 2. Sections and details showing connections, cast-in items and their relation to the structure.
 3. Description of all loose, cast-in and field hardware.
 4. Field installed anchor location drawings.
 5. Erection sequences and handling requirements.
 6. Elevation view of each member.
 7. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts, etc.

- 8. Lifting and erection inserts.
- 9. Dimensions and finishes.
- 10. Method of transportation.
- C. Submit test certificates identifying chemical and physical analysis of materials used for fabrication and physical analysis of the precast product.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Perform transportation, site handling, and erection with acceptable equipment, methods, and by qualified personnel.
- B. Store all units off ground.
- C. Place stored units so that identification marks are easily discernible.
- D. Separate stacked members by battens across full width of each bearing point.
- E. Stack so that lifting devices are accessible and undamaged.
- F. Do not use upper member of stacked tier as storage area for shorter member or heavy equipment.

1.11 SITE ACCESS

- A. Provide suitable access to the building and firm level bearing for the hauling and erection equipment to operate under its own power.

PART 2 PRODUCTS

2.01 PORTLAND CEMENT

- A. Shall be Type I or Type III: ASTM C150.

2.02 AGGREGATES

- A. Lightweight aggregates for concrete: ASTM C330.
- B. Fine and coarse aggregate, other than lightweight aggregate: ASTM C33.

2.03 ADMIXTURES

- A. Air-entraining admixtures: ASTM C260.
- B. Water reducing, retarding, accelerating admixtures: ASTM C494.

2.04 WATER

- A. Potable or free from foreign materials in amounts harmful to concrete and embedded steel.

2.05 REINFORCING STEEL

- A. Reinforcing bars and wire fabric: Per Section 03 21 00, Concrete Reinforcement.
- B. Strand Wire or low relaxation strands: Grade 270K, conforming to uncoated 7-wire stress-relieved strand for prestressed concrete: ASTM A416.

2.06 GROUT

- A. Grout: Per Section 03 61 00, Mortar and Grout and complying with the following:
 - 1. Cement Grout: One (1) part Portland cement, 2-1/2 parts sand, sufficient water for placement and hydration.
 - 2. Nonshrink Grout: Premixed, packaged nonstaining, nonshrink grout.

2.07 BEARING PADS

- A. Use bearing pads of the type recommended by the manufacturer where indicated on the plans.

2.08 WELDED STUDS

- A. Shall be in accordance with A WS D 1.1.

2.09 CAULKING

- A. Shall be a nonstaining 1-part polymer acrylic base sealant.

2.10 CONCRETE MIXES

- A. Precast: The mixture and mixing of concrete shall be in accordance with ACI 304. The mixture shall produce concrete with the 28-day compressive strength no less than 5,000 psi (34.4 MPa)..

2.11 FABRICATION AND MANUFACTURE

- A. The fabrication and manufacture of precast products shall comply with the PCI Manual of Practice, and as specified herein.
- B. Provide for those openings ten (10) inches (250 mm) round or square or larger as shown on the Plans. Other openings may be located and field drilled or cut after the precast products have been erected. Openings shall be approved by the Engineer before drilling or cutting. No tension reinforcement shall be cut.
- C. Patching will be acceptable providing the structural adequacy of the product and the appearance are not impaired.
- D. The manufacturer shall cast in structural inserts, bolts and plates as detailed or required by the Plans or shop drawings.
- E. No imperfections, honeycomb, or other defects shall be permitted. Provide smooth and dense surfaces, free of voids and projections.
- F. Fabricate precast reinforced concrete structures in accordance with ASTM C913, to the dimensions indicated on the plans, and the specified design criteria.

2.12 ACCEPTABLE MANUFACTURERS

- A. Precast concrete decks shall be as manufactured by Price Brothers Company; Concrete Components, Inc.; Precast/Schokbeton; or equal.
- B. Precast concrete steps shall be as manufactured by Unit Step Company; Michigan Precast Concrete; or equal.

PART 3 EXECUTION

3.01 VERIFICATION

- A. Examine the substrates and conditions under which the precast concrete is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Providing true, level bearing surfaces on all field placed bearing walls and other field placed supporting members.
- B. Place and accurately align anchor bolts, plates or dowels in column footings, grade beams and other field placed supporting members.
- C. All shoring required for composite beams and slabs shall conform to all applicable building codes.

3.03 INSTALLATION - GENERAL

- A. Installation of precast prestressed concrete shall be performed by the manufacturer or a competent erector subcontracted by the Contractor. Members shall be lifted by means of

suitable lifting devices at points provided by the manufacturer. Temporary shoring and bracing, if necessary, shall comply with manufacturer's recommendations.

3.04 ALIGNMENT

- A. Members shall be properly aligned and leveled as required by the Shop Drawings. Variations between adjacent members shall be reasonably leveled out by jacking, loading, or any other feasible method as recommended by the manufacturer and acceptable to the Engineer.

3.05 FIELD WELDING

- A. Field welding is to be done by qualified welders using equipment and materials compatible to the base material.

3.06 GROUTING AND CAULKING

- A. After installation of precast units are complete, joints shall be grouted and/or caulked as indicated on the Plans or determined by the Engineer. Joints shall be completely filled with grout. Any grout which seeps through joints shall be removed and surfaces cleaned before the grout hardens.
- B. Caulking shall be used at all underside joints between members and along bearing walls or beams. Concurrently with the caulking and grouting operation, any chipped or damaged sections or areas adjacent to openings or otherwise imperfect surfaces shall be carefully patched to match the precast surface.

3.07 ATTACHMENTS

- A. Subject to the approval of the Engineer, precast prestressed products may be drilled or shot, provided no contact is made with the prestressing steel.

3.08 FIELD QUALITY CONTROL

- A. Final inspection and acceptance of erected precast concrete shall be made by the Engineer to verify conformance with Plans and Specifications.

3.09 SCHEDULES

- A. Precast product quantity, location, surface finish and dimensions shall be as indicated on the Plans.

END OF SECTION

SECTION 03 60 00 GROUTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall provide grout, complete and in place, in accordance with the Contract Documents
- B. The following types of grout are covered in this Section:
 - 1. Cement Grout
 - 2. Non-Shrink Grout - Class I (cement-based)
 - 3. Non-Shrink Grout - Class II (cement-based)
 - 4. Non-Shrink Epoxy Grout
 - 5. Epoxy Anchor Grout for Post Installed Adhesive Anchors
 - 6. Topping Grout and Concrete/Grout Fill

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 03 30 00 - Cast-in-Place Concrete

1.03 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 318-19 - Building Code Requirements for Structural Concrete
 - 2. ACI 350-06 - Code Requirements for Environmental Engineering Concrete Structures
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
 - 2. ASTM C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - 3. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
 - 4. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
 - 5. ASTM C580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, grouts, Monolithic Surfacing, and Polymer Concretes
 - 6. ASTM C648 - Standard Test Method for Breaking Strength of Ceramic Tile
 - 7. ASTM C695 - Standard Test Method for Compressive Strength of Carbon and Graphite
 - 8. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
 - 9. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 10. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

11. ASTM C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
12. ASTM C1090 - Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
13. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
14. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete
15. ASTM C1339 - Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts

1.04 SUBMITTALS

- A. Furnish the following submittals in accordance with Section 01 33 00:
 1. Certified testing lab reports for tests indicated herein.
 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
 3. Certifications that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the Work, and location of use. The current ICC-ES or IAPMO-UES report shall be submitted for all epoxy anchor grouts for adhesive anchors.
 5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
 6. Submit manufacturer's written warranty as indicated herein.
 7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

1.05 QUALITY ASSURANCE

- A. Field Tests:
 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the Owner. The specimens will be made by the Owner or its representative.
 2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C1107 at intervals during construction selected by the Owner. As a minimum, a set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.
 3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 30 00, at intervals during construction selected by the Owner.
 4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C579 at intervals during construction selected by the Owner. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.
 5. The cost of laboratory tests on grout will be paid by the Owner except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the Work.

6. Contractor shall assist the Owner in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.
- B. Construction Tolerances: Construction tolerances shall be as indicated in Section 03 30 00, unless indicated otherwise.
- C. Pre-Installation Demonstration and Training:
 1. Cement and Epoxy-Based Non-Shrink Grouts:
 - a. The grout manufacturer shall give a demonstration and training session for the cement based non-shrink and epoxy grouts to be used on the project, before any installation of grout is allowed.
 - b. Training session shall use a minimum of 5 bags of cement-based non-shrink class I grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates and tie holes to provide on-the-job training for the Contractor and Owner. Contractor employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.
 - c. The manufacturer shall mix enough cement-based non-shrink class II grout for a minimum of 15 tie holes and shall train the Contractor's employees in how to perform the Work and cure the grout. Contractor shall have the employees assisting in the mixing and sealing of the tie holes.
 - d. If the project includes patching, through bolt holes, epoxy anchors, and/or block outs, the manufacturer shall also train the Contractor's employees in the mixing and curing of the epoxy grouts for each of these applications.
 - e. The Contractor shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the Owner.
 2. Epoxy Anchor Grout for Adhesive Anchors:
 - a. Special inspection for all adhesive anchor installations shall be provided:
 - 1) As recommended or required by the ICC-ES or IAPMO-UES report.
 - 2) As required by the enforceable building code.
 - 3) As otherwise indicated in the Contract Documents.
 - 4) The most stringent of the above requirements shall be used. The cost of special inspection of adhesive anchors shall be paid for by the Owner.
 - b. Before installing adhesive anchors in the Work, adhesive anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:
 - c. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading/torquing.
 - 1) Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension. A minimum of 3 anchors shall be tested for each installation position.
 - 2) Anchors shall be tested at 2 times the published allowable tension load or 1-1/4 times the maximum design strength of the anchors in tension as indicated in the ICC-ES or IAPMO-UES report. The test load need not exceed 80 percent of the

nominal yield strength of the anchor, based on steel strength, as determined by ACI 318-19 Chapter 17.

- 3) If any of the 3 test bolts in any installation position fail to reach the test loads, the installer shall be re-tested with the same procedure. Re-testing is required only for the failed installation position.
- 4) An installer who has 3 consecutive successful bolt tests in the first or second trial is considered qualified for adhesive anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the Contractor and be submitted to the Owner.
- 5) The test anchor size shall be the largest size adhesive anchor used on the project. The anchor embedment length and edge distances shall be adequate to resist the test loads listed above.
- 6) Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.
- 7) The certification of each qualified installer shall be available for verification at the Special Inspector's request.
- 8) Defective anchors noted by the Special Inspector shall be replaced and re-installed by the Contractor without any additional compensation.

1.06 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty:

1. Furnish one-year warranty for Work provided under this Section.
 - a. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Application:

1. Unless indicated otherwise, grouts shall be provided as listed in below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts, anchor rods, and reinforcing steel required to be set in grout	Epoxy Anchor Grout
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time exceeds 20 min.)
Under precast concrete elements	Non-Shrink - Class II
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete per 03 31 00
Surface repairs unless indicated otherwise	Cement Grout
Surface repairs less than 4" in their least dimension	Non-Shrink Epoxy
Repair holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I

Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II
Any application not listed above, where grout is indicated	Non-Shrink - Class I, unless specifically indicated otherwise

B. Cement Grout:

1. Cement grout shall be composed of one part of cement, 3 parts of sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland Cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4,000 psi.
2. Cement grout materials shall be as indicated in Section 03 30 00.

C. Non-Shrink Grouts (Cement-Based):

1. General:
 - a. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
 - b. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
 - c. Grout shall not contain chlorides or additives that may contribute to corrosion.
 - d. Grout shall be formulated to be used at any consistency from fluid to plastic.
 - e. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
 - 1) Minimum tensile splitting strength of 500 psi per ASTM C496.
 - 2) Minimum flexural strength of 1,000 psi per ASTM C580.
 - 3) Minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C882.
2. Non-Shrink Grout – Class I:
 - a. Non-Shrink Grout – Class I shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency.
 - b. Non-Shrink Grout – Class I shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
 - c. Non-Shrink Grout – Class I shall have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.
 - d. Non-Shrink Grout – Class I shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.
 - e. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
 - f. Non-Shrink Grout – Class I shall be Masterflow 713 Plus by BASF, Five Star Grout by Five Star Products, SikagROUT 212 by Sika Corporation, DuragROUT by L&M Construction Chemicals; High-Flow Grout by Euclid Chemical Company, CG 200 PC by Hilti, or approved equal.

3. Non-Shrink Grout – Class II:

- a. Non-Shrink Grout – Class II shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.
- b. Non-Shrink Grout – Class II shall have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C827.
- c. Non-Shrink Grout – Class II shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.
- d. Non-Shrink Grout – Class II shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 107.
- e. Non-Shrink Grout – Class II shall meet the requirements of ASTM C1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C939.
- f. The grout when tested shall not bleed or segregate at maximum allowed water content.
- g. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
- h. Non-Shrink Grout – Class II shall be Masterflow 928 by BASF, Five Star Fluid Grout 100 by Five Star Products, SikaGrout 212 by Sika Group, Crystex by L&M Construction Chemicals, or approved equal.

D. Non-Shrink Epoxy Grout:

1. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.
2. Epoxy grout shall have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).
3. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C531.
4. The epoxy grout shall develop a minimum compressive strength of 9,000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, Method B.
5. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.
6. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C1339 for bearing area and flow.
7. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

8. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:
 - a. Minimum bond strength to concrete of 3,000 psi per ASTM C882 modified.
 - b. Minimum bond strength to steel of 1,700 psi per ASTM C882 modified.
 - c. Minimum flexural strength of 2,500 psi per ASTM C580.
 - d. Minimum tensile strength of 2,000 psi per ASTM C307.
9. Non-shrink epoxy grout shall be Five Star DP Epoxy Grout by Five Star Products, Inc., Masterflow 648 CP Plus by BASF, Sikadur 42 Grout-Pak by Sika Corporation, or approved equal.
10. Epoxy Anchor Grout
11. Epoxy anchor grout for use in concrete shall be certified for use in accordance with ICC-ES AC 308.
12. Epoxy anchor grout shall conform to ASTM C881, Type IV, Class B & C, Grade 3 with the exception of gel time.
13. Heat deflection temperature per ASTM D648 shall be a minimum 120 degrees F.
14. Manufacturer shall certify that the epoxy anchor grout will maintain 100 percent of its capacity up to a short-term temperature of 110 degrees F and 50 percent of its capacity up to a short-term temperature of 150 degrees F.
15. Grout shall come in a two (2) chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
16. Epoxy anchor grout shall be capable of being used in submerged applications once cured.
17. Compressive strength per ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
18. Whenever possible, overhead anchors subject to vibration, anchors in fire-resistive construction or high fire risk areas, and anchors subject to working or operating temperatures above 100 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink grout and oversized holes.
19. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar unless otherwise noted on the Contract Documents. Embedment shall not exceed 67 percent of the member depth.
20. Epoxy anchor grout shall be PE1000+ by Powers Fasteners; HIT-RE 500-V3 by Hilti, SET-XP by Simpson Strong-Tie, or approved equal.
- E. Topping Grout and Concrete/Grout Fill:
 1. Where fill thickness is 3-inches or greater, structural concrete, as indicated in Section 03 30 00, shall be used. Omit the coarse aggregate in topping grout used in clarifiers.
 2. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated. Materials and procedures indicated for normal concrete in Section 03 30 00, shall apply unless indicated otherwise.
 3. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 800 pounds of cement per cubic yard with a maximum water cement ratio of 0.42.

4. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent By Weight Passing
1/2 inch	100
3/8 inch	90 - 100
No. 4	20 - 55
No. 8	5 - 30
No. 16	0 - 10
No. 30	0

5. Final mix design shall be as determined by trial mix design as indicated in Section 03 30 00, except that drying shrinkage tests are not required.
6. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 30 00.
7. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 5,000 psi.
8. Topping grout used in clarifiers or where the fill thickness is 3 inches or greater shall contain synthetic fiber reinforcing, unless otherwise shown on the Contract Documents. Synthetic fiber reinforcing shall be in accordance with Section 03 30 00 and shall conform to ASTM C1116, Type III.

F. Curing Materials:

1. Curing materials shall be in accordance with Section 03 30 00, and as recommended by the manufacturer of prepackaged grouts.

G. Consistency:

1. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.
2. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

H. Measurement of Ingredients:

1. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
2. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the Owner.
- C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

- D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the Work from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.02 GROUTING PROCEDURES

- A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.
 - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
 - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the Owner, alternate grouting methods shall be submitted by the Contractor for acceptance by the Owner.
 - 3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.
- C. Drilled Anchors and Reinforcing Bars:
 - 1. General:
 - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions and applicable ICC-ES or IAPMO-UES report requirements. Holes shall be drilled, brushed and cleaned in accordance with the manufacturer's instructions. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has cured for the full cure time indicated by the manufacturer and reached its indicated strength in accordance with the manufacturer's instructions.
 - b. Contractor shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the Owner if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.
 - c. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICC-ES or IAPMO-UES report but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.

- d. Core drilling of holes is not allowed.
 - e. Relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the Work and shall be provided at no additional cost to the Owner.
 - f. Abandoned drilled holes shall be filled with Epoxy Anchor Grout.
2. Epoxy Adhesive Anchors:
- a. Grout shall be proportioned and mixed per the manufacturer's instructions.
 - b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICC-ES or IAPMO-UES report but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.
 - c. Holes shall be dry.
3. Cement Based Non-Shrink Grout used for Anchorage:
- a. In places of high temperature or fire hazard, anchor bolts and anchor rods shall be grouted in using cement based non-shrink grout, Class I.
 - b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor bolt, anchor rod or reinforcing bar per the manufacturer's ICC-ES or IAPMO-UES report but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
 - c. When the anchor bolt or anchor rod diameter is one-inch or less, the hole diameter shall be a minimum of 2-inches. When the anchor bolt/rod diameter is greater than one-inch, the hole diameter shall be at least twice the anchor bolt/rod diameter.
 - d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
4. The non-shrink grout shall be placed in the holes in a non-sag (trowelable) consistency. The grout shall be placed in the holes before the anchor bolt/rod and then the anchor bolt/rod inserted and vibrated to ensure proper coverage.
- D. Topping Grout and Concrete/Grout Fill:
- 1. Mechanical, electrical, and finish Work shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by the Owner, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.
 - 2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
 - 3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) - Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The

topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the Owner, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.03 CONSOLIDATION

- A. Grout shall be placed in such a manner that the space to be grouted is completely filled.

3.04 CURING

- A. Cement-based grouts shall be cured per Section 03 30 00 and per the manufacturer's recommendations.

END OF SECTION

SECTION 05 12 00 STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The extent of structural steel work is indicated on the Plans, including schedules, notes, and details to show size and location of members, typical connections, and type of steel required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 - Cast-in-Place Concrete
- B. Section 04 05 11 - Mortaring and Grouting
- C. Section 05 50 00 - Metal Fabrications
- D. Section 05 53 00 - Gratings

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM A6/A6M: Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
 - 2. ASTM A53/A53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 3. ASTM A194/A194M: Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - 4. ASTM A307: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
 - 5. ASTM A500/A500M: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - 6. ASTM A563/A563M: Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
 - 7. ASTM A572/A572M: Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
 - 8. ASTM A992/A992M: Standard Specification for Structural Steel Shapes
 - 9. ASTM E164: Standard Practice for Contact Ultrasonic Testing of Weldments
 - 10. ASTM F436/F436M: Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
 - 11. ASTM C1107/C1107M: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - 12. ASTM F3125/F3125M: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
 - 13. SSPC-SP 2: Steel Structures Painting Council, "Hand Tool Cleaning"
 - 14. SSPC-SP 3: Steel Structures Painting Council, "Power Tool Cleaning"

1.04 CODES AND STANDARDS

- A. Comply with the provisions of the following, except as otherwise indicated.

1. AISC - "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC - "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings," including the "Commentary and Supplements" thereto as issued.
3. RCSC (HSBOLT) - "Specification for Structural Joints Using High-Strength Bolts," approved by the Research Council on Structural Connections (RCSC) with the participation of AISC.
4. AWS D1.1/D1.1M - "Structural Welding Code."
5. ASTM A6/A6M - "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."

1.05 QUALIFICATIONS FOR WELDING WORK

- A. Qualify welding processes and welding operators in accordance with the AWS B2.1/B2.1M "Specification for Welding Procedure and Performance Qualification."
- B. Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months.
- C. If recertification of welders is required, retesting will be the Contractor's responsibility.

1.06 DESIGN OF MEMBERS AND CONNECTIONS

- A. Details indicated on the Plans are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at the site whenever possible without causing delay in the Work.
- B. Connection details not shown on the plans shall be designed in accordance with the most current addition of the AISC "Manual of Steel Construction."
- C. Promptly notify the Engineer whenever design of members and connections for any portion of the structure is not clearly indicated.

1.07 ALLOWABLE TOLERANCES

- A. Overall Length:
 1. Members with both ends milled for contact bearing: $\pm 1/32$ inch.
 2. Members without ends milled for contact bearing which are framed to other members:
 - a. 30 feet or less in length $\pm 1/16$ inch.
 - b. Over 30 feet in length $\pm 1/8$ inch.
- B. Straightness:
 1. Structural members may vary from straightness within the tolerances allowed for wide flange shapes by ASTM A6/A6M, except that the tolerance on deviation from straightness of compression members is 1/1,000 of the axial length between points which are to be laterally supported.
 2. Completed members should be free from twists, bends and open joints. Sharp kinks or bends are cause for rejection of material.
- C. Individual pieces shall be erected so that the deviation from plumb, level and alignment shall not exceed 1:500.

1.08 SOURCE QUALITY CONTROL

- A. Materials and fabrication procedures are subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

- B. Promptly remove and replace materials or fabricated components which do not comply.

1.09 SUBMITTALS

- A. For information only, submit two (2) copies of producer's or manufacturer's specifications and installation instructions for the following products including laboratory test reports and other data as may be required to show compliance with these specifications (including specified standards). Indicate by transmittal that copy of each applicable instruction has been distributed to fabricators, installers, and erectors.
 - 1. Structural Steel, including certified copies of mill reports covering the chemical and physical properties.
 - 2. High-strength bolts including nuts and washers.
 - 3. Unfinished bolts and nuts.
 - 4. Structural steel primer paint.
 - 5. Shrinkage-resistant grout.
 - 6. Slide bearings.
- B. Submit shop drawings, prepared by a professional engineer registered in the state of Michigan, including complete details and schedules for fabrication and shop assembly of members, connections, and details. Also include schedules, procedures, and diagrams showing the sequence of erection.
- C. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
- D. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages to be installed by others.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site at such intervals to insure uninterrupted progress of the work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
- C. Do not store materials on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replace damaged materials or structures as directed by the Engineer.

1.11 SEQUENCING WITH RELATED WORK

- A. Supply fabricated structural steel members and/or accessories to be installed by related Work. Bearing plates shall be furnished complete with anchor bolts, washers, nuts and setting diagrams or templates.

1.12 ENVIRONMENTAL REQUIREMENTS

- A. Allowances shall be made during erection of structural steel for ambient air temperatures specified in Part 3 of this Section.

PART 2 PRODUCTS

2.01 STRUCTURAL STEEL

- A. Rolled Steel Wide Flange and Tee Shapes: ASTM A992/A992M.
- B. Other Rolled Steel Plates, Shapes, and Bars: ASTM A572/A572M, G50, unless otherwise indicated on the plans.
- C. Anchor Bolts: ASTM A307, nonheaded type unless otherwise indicated on the Plans.

2.02 WASHERS, BOLTS, AND NUTS

- A. Washers: ASTM F436/F436M
- B. Bolts and Nuts:
 - 1. Standard: ASTM A307, Grade A , with nuts conforming to ASTM A563/A563M, Grade A.
 - 2. High Strength: ASTM F3125/F3125M, Grade A325, Type 1, with heavy hex nuts conforming to ASTM A563/A563M, Grade DH.
 - 3. Alloy Steel: ASTM F3125/F3125M, Grade A490, Type 1, with ASTM A194/A194M heavy hex nuts.

2.03 MISCELLANEOUS STRUCTURAL ITEMS

- A. Electrodes for Welding: Comply with AWS Code; Use E 70 XX Series.
- B. Structural Steel Primer Paint: Inorganic Zinc-Rich Epoxy Primer Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C588, Type A.

2.04 SHOP FABRICATION AND ASSEMBLY

- A. Fabricate and assemble structural assemblies in the shop to the greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on the final shop drawings. Provide camber in structural members where indicated on the Plans.
- B. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
- C. Where finishing is required, complete the assembly, including welding of units before start of finishing operations. Provide finish surfaces of members exposed in the final structure free of markings, burrs, and other defects.

2.05 CONNECTIONS

- A. Weld or bolt shop connections as indicated on the Plans.
- B. Bolt field connections except where welded connections or other connections are specified.
- C. Provide high-strength threaded fasteners for all principal bolted connections, except where unfinished bolts are indicated on the Plans.
- D. Provide unfinished threaded fasteners for only the bolted connections of secondary framing members to primary members (including purlins, girts, and other framing members taking only nominal stresses) and for temporary bracing to facilitate erections.
- E. Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A325 or A490 Bolts".
- F. Comply with AWS Code for procedures, appearance, quality of welds, and methods used in correcting welding work.
- G. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

2.06 HOLES FOR OTHER WORK

- A. Provide holes required for securing other work to structural steel framing, and for the passage of other work through steel framing members as indicated on the Plans and/or final shop drawings.
- B. Provide threaded nuts welded to framing, and other specialty items as indicated on the Plans, and/or final shop drawings to receive other work.

- C. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.07 SHOP PAINTING

- A. Shop paint structural steel work, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel which is partially exposed on portions which are exposed and initial two 2 inches of embedded areas only.
- B. Do not paint surfaces which are to be welded or high-strength bolted with friction-type connections.
- C. After inspection and before shipping, clean all steel work whether painted or not. Remove loose rust, loose mill scale, spatter, slag, or flux deposits. Clean steel in accordance with SSPC-SP 2 and SSPC-SP 3.
- D. Immediately after surface preparation, apply structural steel primer paint in accordance with the manufacturer's instructions and at a rate to provide a uniform dry film thickness at 2 mils. Use painting methods which will result in full coverage of joints, corners, edges, and all exposed surfaces.

PART 3 EXECUTION

3.01 VERIFICATION

- A. Contractor and erector must examine the areas and conditions under which structural steel work is to be installed and notify the Engineer, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor and erector.
- B. The inspection and verification of construction in place shall be sufficiently in advance of steel erection to allow for possible correction of the construction in place or fabrication.
- C. If the construction in place is not inspected by the Contractor prior to erection, the Contractor shall be responsible for removing and resetting construction in place or revisions in fabrication to correct discrepancies.

3.02 ERECTION - GENERAL

- A. Comply with the AISC Specifications and Code of Standard Practice, and as herein specified.

3.03 TEMPORARY SHORING AND BRACING

- A. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.

3.04 TEMPORARY PLANKING

- A. Provide temporary planking and working platforms as necessary to effectively complete the Work.

3.05 ANCHOR BOLTS

- A. Furnish anchor bolts and other connectors required for securing structural steel to foundations.
- B. Furnish templates and devices as necessary for presetting bolts and other anchors to accurate locations. Templates shall be 1/8 inch thick (min) steel plate.

3.06 SETTING BASES AND BEARING PLATES

- A. Clean concrete bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.

- B. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
- C. Tighten the anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
- D. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain.
- E. Finish exposed surfaces, protect installed materials, and allow to cure in strict compliance with the manufacturer's installations, or as otherwise required.

3.07 FIELD ASSEMBLY

- A. Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces which will be in permanent contact.
- B. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- C. Level and plumb individual members of the structure as specified in Part 1 of this Section unless otherwise specified by AISC tolerances.
- D. Establish required leveling and plumbing measurements on the mean operating temperature of the structure. Make allowances for the difference between temperature at time of erection and the mean temperature at which the structure will be when completed and in service.
- E. Splice members only where indicated on the Plans and/or final shop drawings.
- F. Erection bolts on exposed welded construction, shall be removed and holes filled with plug welds and ground smooth at exposed surfaces.
- G. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
- H. Do not enlarge undersized holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- I. Do not use cutting torches in the field for correcting fabrication errors in the structural framing. Cutting will be permitted only on secondary members which are not under stress, as acceptable to the Engineer. Finish gas-cut sections equal to a sheared appearance when field cutting is permitted.

3.08 TOUCH-UP PAINTING

- A. Immediately after erection clean field welds, bolted connections, and abraded areas of the shop paint. Apply paint to exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2 mils.

3.09 FIELD QUALITY CONTROL

- A. General:
 - 1. Owner may engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports. Inspections will meet the requirements of the current building code at the place of the Work.
 - 2. The testing agency shall conduct and interpret the tests and state in each report whether the test specimens comply with the requirements, and specifically state any deviations therefrom.

3. Provide access for the testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.
4. The testing agency may inspect structural steel at the plant before shipment; however, the Engineer reserves the right, at any time before final acceptance to reject material not complying with specified requirements.
5. Contractor shall correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Performance of additional tests as may be necessary to reconfirm any noncompliance of the original work, and as may be necessary to show compliance of corrected work will be at the Contractor's expense.
6. Work determined to be defective by the Engineer and/or local agencies regardless of all previous inspections, shall be corrected to the satisfaction of the Engineer at no extra cost to the Owner. Contractor shall be responsible for the cost and delay of replacing defective Work both in regard to his own Contract and as such cost or delay affects the Work of others.

B. Connections:

1. Inspect shop bolted connections in accordance with AISC Specifications.
2. Inspect and test not less than five (5) percent of the shop and field welds during fabrication and erection of structural steel assemblies as follows:
 - a. Certify welders and conduct inspections and tests as required.
 - b. Record types and locations of all defects found in the work.
 - c. Record work required and performed to correct deficiencies.
 - d. Perform visual inspection of all welds complying with ASTM E164.
3. Inspection of field bolted connections will be in accordance with AISC Specifications.

END OF SECTION

SECTION 05 50 00 METAL FABRICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes shop fabricated steel and aluminum items as indicated on the Plans complete with materials, fabrication and installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 15 00 - Concrete Accessories
- B. Section 03 30 00 - Cast-in-Place Concrete
- C. Section 05 12 00 - Structural Steel Framing

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ASTM A36/A36M: Standard Specification for Carbon Structural Steel
 - 2. ASTM A53/A53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 3. ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 4. ASTM A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 5. ASTM A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 6. ASTM A276/A276M: Standard Specification for Stainless Steel Bars and Shapes
 - 7. ASTM A500/A500M: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - 8. ASTM A501/A501M: Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - 9. ASTM B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - 10. ASTM B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - 11. ASTM B429/B429M: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
 - 12. AISC 303: Code of Standard Practice for Steel Buildings and Bridges
 - 13. AWS D1.1/D1.1M: Structural Welding Code - Steel
 - 14. Federal Specifications (FS)
 - 15. Occupational Safety and Health Act (OSHA)

1.04 DESIGN CRITERIA

- A. Grating, railings, stairs and hatches shall be capable of supporting loads as indicated unless otherwise shown on the Plans.
- B. Gratings, Hatches and Stairs:

1. Uniformly distributed load of 150 lbs / sft of horizontal surface.
 2. Maximum allowable deflection is 1/4 inch with 150 lbs / sft uniformly distributed load or 500 lbs concentrated load applied at midspan.
- C. Stairway and ladder design shall conform to the latest federal and state requirements for loading, rail sizes, and dimensions.

1.05 REQUIREMENTS OF REGULATORY AGENCIES

- A. The latest Federal OSHA Standards, as adopted by the State of Michigan, and as they relate to floor and wall openings, grating, stairways, ladders and skylights, shall apply to the Work of this specification where applicable.
- B. Expansion anchor bolts shall meet federal and state OSHA requirements for pull-out and shear.

1.06 SUBMITTALS

- A. Submit shop drawings showing layout, fabrication dimensions, anchoring details and erection information for stair nosings, ladders, grating and floor hatches. Include pull-out and shear-strength information for recommended anchor bolts.
- B. Fabrication and/or erection of items done prior to Engineer review of shop drawing shall be at the risk and expense of the Contractor.
- C. When requested by the Engineer, submit mill or laboratory certified copies of testing reporting chemical analysis and physical property of metal used in fabrication of items of this Section.
- D. Submit affidavits when requested by the Engineer, certifying that the grating, handrail, and ladder capacities comply with the requirements as specified and indicated in this Section or on the Plans.
- E. Certification that the equipment meets federal and state OSHA standard for Climber Protection shall be submitted.

1.07 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
1. Design connections and components not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of Michigan.
- B. Inspection:
1. Work done in accordance with this specification shall be subject to inspection. Owner/Engineer shall have access to all places of manufacture where materials are being produced or fabricated, or where tests are being conducted and shall be accorded full facilities for inspection and observation.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver miscellaneous metal items in an undamaged condition. Damaged items shall be repaired or replaced to the satisfaction of the Owner at the expense of the Contractor.
- B. Store items to permit easy access for inspection and identification. Keep items off the ground, using pallets, platforms, or other supports. Protect unpackaged and packaged items from erosion and deterioration of shop paint or finish surface.
- C. Do not store on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replacement shall be to the satisfaction of the Owner at the expense of the Contractor.

1.09 PROTECTION

- A. All installed anchor bolts, inserts and other miscellaneous metal items shall be protected while other Work is being performed. Installed items that are damaged shall be repaired or replaced at the Contractor's expense.

1.10 SEQUENCING

- A. Anchors, frames, or other miscellaneous metal items to be embedded in concrete shall be provided on site as required for uninterrupted construction sequence.

1.11 GUARANTEE

- A. The floor hatches shall bear the manufacturer's 5-year guarantee for proper operation and against defects in materials and workmanship.

PART 2 PRODUCTS

2.01 ZINC COATING

- A. Unless otherwise indicated on the Plans or specified herein, miscellaneous metals shall receive zinc coatings as follows:
 - 1. Steel Shapes, Plates or Bars: ASTM A123/A123M
 - 2. Hardware of Steel or Iron: ASTM A153/A153M
 - 3. Assembled Steel Products: ASTM A123/A123M

2.02 PLATES, SHEETS, SHAPES AND BARS

- A. Steel: ASTM A36/A36M
- B. Aluminum
 - 1. Plate and Sheet: Alloy 6061, Temper T6, ASTM B209/B209M
 - 2. Extruded Shapes and Bars: Alloy 6061-T6, ASTM B221
- C. Stainless Steel
 - 1. Shapes and Bars: ASTM A276/A276M
 - 2. Sheets: ASTM A240/A240M

2.03 TUBING

- A. Steel:
 - 1. Hot-Formed Welded and Seamless – ASTM A501/A501M, Grade C
 - 2. Cold Formed – ASTM A500/A500M, Grade C
- B. Aluminum: Alloy 6061-T6, ASTM B221

2.04 PIPE

- A. Black finish unless otherwise specified, Type E or S, Grade B, Schedule 40, ASTM A53/A53M
- B. Aluminum: Alloy 6061-T6, ASTM B429/B429M

2.05 EXPANSION ANCHOR BOLTS

- A. In accordance with Section 03 15 00 - Concrete Accessories.

2.06 GRATING AND STAIR TREADS

- A. Steel:
 - 1. Minimum 3/16 inch thick bearing bars manufactured from USS "Cor-Ten" Steel with Blaw-Knox Ponbake, Bordon Bo-Ly, or approved equal finish.

2. Stair treads shall have minimum 1 inch wide diamond plate nosings.
- B. Aluminum:
 1. Standard rectangular bar manufactured from Alloy 6061-T6, ASTM B221 with standard finish. Stair treads shall have abrasive nosings.

2.07 CONCRETE STAIR NOSING

- A. Ferrous metal tread nosing with abrasive tread surface. Nosing shall be minimum 1/8 inch thick, shall have a minimum of 4 inch legs on the horizontal surface of the tread and 2 inch leg on the vertical surface of the riser, and shall extend the full width of the tread.
- B. Nosing shall be integral with the concrete stairs by steel studs or anchors. Nosing shall be painted with an approved epoxy paint system.

2.08 RAILINGS

- A. Pipe railing system shall consist of top and intermediate rail with posts and kickplates. Handrail system for stairs shall consist of top and intermediate rail, and posts.
- B. Aluminum rail and posts shall be nominal 1-1/2 inch diameter, Schedule 40. Fittings shall be extruded aluminum, machined to final shape. Fasteners shall be stainless steel. Fabricate railing systems and handrails for connection of members by means of manufacturer's standard concealed mechanical fasteners and fittings unless otherwise approved.
- C. Steel rails and posts shall be minimum 1-1/2 inch diameter, schedule 40, black steel pipe of flush welded construction.

2.09 LADDERS

- A. All items for ladders and associated safety devices shall be manufactured from aluminum alloy as stated above with stainless steel anchor bolt unless otherwise noted on the plans.

2.10 HATCHES

- A. Frames shall be neatly mitered and shall have welded corners and anchors.
- B. Aluminum surfaces to come in contact with concrete, wood, and dissimilar metals shall be shop coated with alkali resistant bitumastic paint as specified in Division 9 of the Technical Specifications.
- C. Provide each access hatch assembly manufactured as an integral unit, complete with all parts and ready for installation.
- D. Aluminum access hatches and frames: Fabricate units of continuous welded aluminum construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure frames to types of floor or walkway shown on Drawings.
- E. Covers: Covers shall be mill finish aluminum 1/4-inch diamond pattern, reinforced on the underside. Covers shall open to 90 degrees and lock automatically in that position.
- F. Channel Frame: Channel frame shall be 1/4-inch extruded aluminum with bituminous coating applied to the exterior of the frame and with full anchor flange and welded anchors for concrete installation around the perimeter.
- G. For watertightness, furnish frame with formed gutters a minimum of 3-inch wide by 3-inch deep, anchors, and a welded 1-1/2-inch drain coupling located on the right front corner of the channel frame or in another corner if shown on Drawings or specified otherwise. Fully weld gutter frame for absolute weathertightness.
- H. Hinges, Pins, Bolts, and Nuts: Provide the covers with heavy 12 gauge, No. 316 stainless steel hinges and stainless steel pins. Hinges shall pivot so the cover does not protrude into channel

frame. Hinges shall be through-bolted to the cover with stainless steel lock bolts and shall be through-bolted to the frame with stainless steel bolts and lock nuts.

- I. Springs, Tubes, Shoes, Plates, Enclosures, and Operators: Provide the covers with manufacturer's standard springs, tubes and caps, tube or spring enclosures, operators, support plates, and shoes, which shall allow ease of operation through the entire 90-degree arc of opening, and act as a check in retarding downward motion when being closed. Tube and spring enclosures shall prevent accumulation of moisture, grit, and debris inside the tube and spring assembly.
- J. Hold-Open Arms: Provide the covers with hold-open arms with guides which automatically lock the covers in the open position. Vinyl covered release handles shall be provided and conveniently located for closing.
- K. Interior Snap Lock and Lock Strike: Provide a stainless steel snap lock and lock strike with a stainless steel fixed turn handle and appropriate stainless steel bolts mounted on the underside of the covers.
- L. Exterior Lift Handle: Provide the covers with a stainless steel lift handle designed to be flush with walking surface when not in use.
- M. Locking and Latching Devices: Provide the covers with the following locking or latching device and related hinged lid, flush gasketed removable screw plug, or threaded cover plug as noted:
 - 1. Interior access hatches shall have removable exterior latch handle with plug: Provide removable exterior stainless steel latch handle and latch release protected by a flush gasketed removable screw plug.
 - 2. Exterior access hatches shall have cylinder lock: Provide a brass cylinder lock with keyway protected by a threaded cover plug. Equip lock with cylinder and keys as specified.
- N. Hardware Finish: Except where noted otherwise, all hardware shall be zinc plated and chromate sealed.
- O. Accessories
 - 1. Provide ladder safety posts at fixed ladders and manhole rungs located below access hatches.
 - a. Safety posts shall be designed with telescoping section that locks automatically when fully extended. Up and down movement shall be controlled by a stainless steel spring balancing mechanism.
 - b. Unit shall be completely assembled with fasteners for securing to ladder rungs in accordance with manufacturer's instructions. Finish to match ladder served.
 - c. Safety post shall be Bilco Ladder Up, or approved equal.
 - 2. Provide fall prevention device below floor doors.
 - a. The fall prevention device shall be permanently installed fall-through prevention system that is easily retractable for full access and allows visibility for inspection.
 - b. The product must be FRP or stainless steel Type 316. Grating shall have a live load capacity of 100 pounds per square foot.

2.11 FABRICATION

- A. General:
 - 1. Miscellaneous steel fabrications shall conform to AISC 303. Welding where permitted and performed shall be in accordance with AWS D1.1/D1.1M.

2. Fabricate items to dimensions on plans or Engineer approved shop drawings. Use the type of materials of size and thickness as indicated on the Plans or specified herein. All structural members framing into beams or columns, unless otherwise detailed on the Plans, shall have standard framing connection angles of sufficient strength to develop the full strength of the member, even though the design stress may be less.
 3. Connections shall be bolted, welded or other Engineer approved means. Exposed connections shall be flush. Grind welds smooth to match and blend with adjoining surfaces.
 4. Ferrous metal fabrications not to be galvanized or embedded in concrete shall be coated with a primer as specified in Division 9 of the Technical Specifications or as specified for individual items.
- B. Grating and Stair Treads:
1. Grating shall be fabricated with span lengths and panel widths as indicated on the Plans. Bearing and cross bars shall be spaced evenly and provide the required loading capacity. All edges of grating panels shall be solid, flush for the full depth of the grating.
- C. Ladders:
1. Ladders shall be fabricated in accordance with the details shown.
 2. Ladder climbing safety devices such as cages shall be provided for all ladders 20 feet or greater in length.
- D. Guard Chains:
1. Where indicated on the Plans, chains shall be 3/16 inch cadmium plated steel link construction, provided with snap-type fasteners at each end to permit attachment to posts and/or wall eyelets. Two (2) strands of chain, mounted at heights equal to guardrails, shall be installed wherever noted on the Plans.
- E. Guard Posts:
1. Guard posts shall be 6 inch diameter, steel pipe conforming to ASTM A53/A53M, Schedule 80, filled with concrete. Guard Posts shall be galvanized steel unless otherwise shown on the plans. Guard posts to be painted shall have:
 - a. 2 - 3 mil polyamide epoxy primer,
 - b. 2 - 3 mil aliphatic acrylic polyurethane, semi-gloss
 - c. Total dry film thickness 4 - 6 mils

2.12 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers of steel grating include: Blaw-Knox "Cor-Ten" steel with "Ponbake" finish; Gary Bo-Ly; or equal.
- B. Acceptable manufacturers of aluminum grating include: Reliance Steel Products Company; Gary Aluminum Grating, manufactured by IKG Industries; or equal.
- C. Acceptable manufacturers of floor hatches include: Babcock-Davis Associates, Inc.; Bilco Company; Halliday Products Inc., or equal.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Miscellaneous metal items shall be installed plumb, level, square and true, set at proper elevations and positioning. Bearing surfaces and surfaces to be in permanent contact shall be cleaned of all dirt, rust, and all other substances before the members are assembled.

- B. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

3.02 INSTALLATION OF ANCHOR BOLTS

- A. Drill holes of diameter and depth recommended by anchor manufacturer. Clean hole of dust and debris before inserting anchor. Assemble anchor and complete installation according to manufacturer recommendations.

3.03 INSTALLATION OF GRATING, FLOOR HATCHES AND STAIR NOSINGS

- A. Install items at locations indicated on the Plans in accordance with manufacturer's recommendations. Frames to be embedded in concrete shall be installed flush with the finished floor and shall be carefully leveled so that the plates of gratings do not rock.
- B. Install stair nosings on all concrete stairs.
- C. Install eyelets in walls and/or posts for securing guard chains as indicated on the Plans. Mount chain strands at elevations equal to railings.

3.04 INSTALLATION OF GUARD POSTS

- A. Guard posts shall be set a minimum of 42 inch below finished grade in a concrete foundation as shown on the Plans. Guard posts shall extend 5 feet above finished grade.

3.05 INSTALLATION OF RAILINGS

- A. Provide pipe railing system with maximum 8 foot maximum post spacing and minimum 42 inch railing height to top rail. Top rail of handrailing system shall be 34 inches high as measured from the leading edge of any tread. Provide minimum 3 inch clearance from the wall for single pipe handrail supported on brackets.
- B. Provide removable pipe railings with close-fitting sleeves set in concrete where indicated on the Plans. Sleeves shall be 1 inch less in length than thickness of concrete.

3.06 INSTALLATION OF HATCHES

- A. Comply with manufacturer's instructions for installation of floor, pit, and sidewalk doors.
- B. Coordinate installation with Work of other trades.
- C. Preparatory Work: For normal flush installation, set frames accurately in position, recessed below the finished grade or floor level with cover face panels plumb or level in relationship to adjacent finish surfaces.
 - 1. If unit is watertight type, unit should be set with slight pitch in direction of drain coupling.
- D. All four corners of the frame shall be in the same plane; verify that leaves are seated properly on frame all around. Securely attach units to supports.
- E. For flush installation, pour concrete to top of frame. Aluminum surfaces in contact with concrete shall be coated with a bituminous coating prior to installation.
- F. Adjust hardware and covers after installation for proper operation.
- G. Remove and replace covers or frames which are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 05 50 01 MISCELLANEOUS METAL WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 60 00 - Grouting
- B. Section 05 55 13 - Wedgewire Screens

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Federal Specifications:
 - 1. MIL-PRF-907F Anti-seize Thread Compound, High Temperature
- B. Codes:
 - 1. OSHA 1927.10 Fixed Ladders
- C. Aluminum Association Designation System (AA):
 - 1. AA-M32C22A41 Aluminum Assn.
- D. American Association of State Highway and Transportation Officials:
 - 1. AASHTO HL-93 Truck Loading
- E. American Institute of Steel Construction (AISC):
 - 1. AISC Manual of Steel Construction
- F. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36 Carbon Structural Steel
 - 2. ASTM A48 Gray Iron Castings
 - 3. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 4. ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 5. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 6. ASTM A193 Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Application
 - 7. ASTM A194 Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service
 - 8. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 9. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
 - 10. ASTM A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 11. ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - 12. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - 13. ASTM A992 Structural Steel Shapes

14. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
 15. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength
- G. American National Standards Institute (ANSI):
1. ANSI/AWS D1.1 Structural Welding Code - Steel
 2. ANSI/AWS D1.2 Structural Welding Code - Aluminum
 3. ANSI/AWS D1.6 Structural Welding Code - Stainless Steel
 4. ANSI/AWS QC1 Standard for AWS Certification of Welding Inspectors

1.04 SUBMITTALS

- A. Shop Drawings:
1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.
 2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.
- B. Anchors:
1. Submit an ICC-ES or IAPMO-UES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor.
 2. Submit manufacturer's recommended installation instructions and procedures for anchors.
 3. Upon review by the Owner, these instructions shall be followed specifically.
 4. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.
 5. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be signed and stamped by a Professional Engineer registered in the state of Ohio.
- C. Grating:
1. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.
 2. Submit load and deflection tables for each style and depth of grating used.
- D. Wedgewire Screens:
1. Submittal for Wedgewire screen support frames and anchorages shall be coordinated with the requirements of Section 05 55 13.

1.05 QUALITY ASSURANCE

- A. Weld procedures and welder qualifications shall be available in the Contractor's field office for review.
- B. Welding Special Inspection will be performed by the Owner in accordance with the enforceable Building Code.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Carbon Steel:

Wide Flange Shapes	ASTM A992
Shapes, Plates, Bars	ASTM A36
Pipe, Pipe Columns, Bollards	ASTM A53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A500 Grade B

B. Corrosion Protection:

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of Section 09 96 00 - Painting and shall not be galvanized prior to coating.
2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. Stainless Steel:

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

D. Aluminum:

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.
2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 90 00.

E. Cast Iron:

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B, or better.

2.02 LADDERS

A. Materials:

1. Ladders shall be fabricated entirely of Type 316 stainless steel unless specified otherwise on the Drawings.

B. Pop-Up Extension:

1. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension.
2. The pop-up extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.
3. Upward and downward movement shall be controlled by stainless steel spring balancing mechanisms.
4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.
5. Pop-up extension shall be the LadderUP Safety Post as manufactured by Bilco or approved equal.

2.03 METAL GRATING

A. General:

1. Metal grating shall be of the indicated design, size, and type.
2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.
 4. Banding:
 - a. The grating shall be completely banded at edges and cutouts.
 - b. The banding material and cross-section shall be equivalent to the bearing bars.
 - c. The banding shall be welded to each cut bearing bar.
 5. The grating pieces shall be fastened to each support in 2 locations.
 6. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less.
 7. Design Loading:
 - a. For standard duty grating, the loading to be used for determining stresses and deflections shall be the uniform live load of 100 psf, or a concentrated load of 1000 pounds.
 - b. For heavy duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HL-93.
 8. All grating shall be provided with The Intimidator ManLock by McGard or approved equal locking mechanism.
 - a. ManLock shall use 1/2" – 13- 2.75" bolt
- B. Material:
1. Except where indicated otherwise, bar grating shall be fabricated entirely of:
 - a. Heavy duty welded steel, hot-dipped galvanized after fabrication
 - 1) Bearing Bars: shall be spaced at 15/16 inch center-to-center. Depth of bar shall be as indicated on drawings.
 - 2) Cross Bars: shall be spaced at 4 inches center-to-center
 - 3) Surface: plain
 - 4) Loading: HL-93
 - 5) Finish: hot-dipped galvanized
 - 6) Fabrication and Tolerances: in accordance with the NAAMM Heavy Duty metal bar Grating Manual
 2. Grating that may be partially or wholly submerged shall be fabricated of A316L stainless steel.

2.04 CHECKERED PLATE

- A. Checkered plate shall be provided with a pattern of raised lugs on one face, and shall be smooth on the opposite face.
- B. Lugs:
 1. Lugs shall be a minimum of one inch in length and raised a minimum of 1/2 inch above the surface.
- C. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions.
 1. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

- D. Where no material is indicated, the plates shall be fabricated from aluminum.
- E. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4 inch, or the span divided by 240, whichever is less.

2.05 IRON CASTINGS

- A. General:
 - 1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects.
 - 2. The castings shall be smooth and well cleaned by shotblasting.
 - 3. Covers and grates shall fit together evenly, such that the cover fits flush with the surrounding finished surface and such that the cover does not rock or rattle when a loading is applied.
 - 4. Round covers and frames shall be provided with machined bearing surfaces
- B. Covers with matching frames shall be designed for AASHTO HL-93 loading, heavy traffic type and conform to the requirements of ASTM A 48 Class 30 unless indicated otherwise.

2.06 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application):
 - 1. Bolts, anchor rods, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.
 - 2. Threads on galvanized bolts, rods and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.
 - 3. Except as otherwise indicated, steel for bolt material, anchor rods, anchor bolts, and cap screws shall be in accordance with the following requirements:
 - a. Structural Connections: ASTM 307, Grade A or B, hot-dip galvanized
 - b. Headed Anchor Rods and Anchor Bolts: ASTM F1554, Grade 36, hot-dip or mechanically galvanized with Grade A matching nuts
 - c. High-Strength Bolts, where indicated: ASTM A325
 - d. Pipe and Equipment Flange Bolts: ASTM A193, Grade B-7
- B. Corrosive Service:
 - 1. Bolts, anchor rods, anchor bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.
 - a. Buried locations
 - b. Submerged locations
 - c. Locations subject to seasonal or occasional flooding
 - d. Inside hydraulic structures below the top of the structure
 - e. Inside buried vaults, manholes, and structures
 - f. Locations indicated or designated by the Owner to be provided with stainless steel bolts
 - 2. Unless otherwise indicated, stainless steel bolts, anchor rods, anchor bolts, nuts, and washers shall be fabricated from Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.
- C. Coating:

1. Threads on stainless steel bolts and rods shall be protected with an anti-seize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.
 2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
 3. Anti-seize lubricant shall be classified as acceptable for potable water use by the NSF.
 4. Anti-seize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL, 60131, AS-470 by Dixon Ticonderoga Company, Lakehurst, NJ, 08733, or approved equal.
- D. Bolt Requirements:
1. The bolt and nut material shall be free-cutting steel.
- E. The nuts shall be capable of developing the full strength of the bolts.
1. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
 2. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
 3. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.
 4. Lock washers fabricated from material matching the bolts shall be installed where indicated.
 5. The length of each bolt shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.
- F. Adhesive Anchors:
1. General:
 - a. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors.
 - b. No substitutions will be considered unless accompanied with a current ICC- ES or IAPMO-UES report verifying strength and material equivalency.
 2. Epoxy Anchors:
 - a. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars.
 - b. Epoxy shall be in accordance with the requirements of Section 03 60 00.
 - c. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.
 - d. Epoxy anchors shall not be permitted in areas where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer, whichever is lower.
 - e. Epoxy anchors shall not be used where anchors are subject to vibration or fire.
 - f. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.
 3. Unless otherwise noted, threaded rod shall be galvanized steel.

G. Expanding-Type Anchors:

1. Expanding-type anchors, if indicated or permitted, shall be galvanized steel unless otherwise noted, shall be of the expansion type, and shall be Simpson Strong-Tie Strong-Bolt 2 anchors, Hilti Kwik-Bolt TZ anchors, Powers Power-Stud+ SD1 or SD2 anchors, or equal.
2. Lead caulking anchors will not be permitted.
3. Minimum size shall be as indicated on the Contract Documents.
4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

H. Non-Shrink Grouted Anchors:

1. Grouted anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendations.
2. Non-shrink grout material shall be Class B or C in accordance with Section 03 60 00.

2.07 IMPACT ANCHOR

- A. Impact anchors shall be an expansion-type anchor in which a nail-type pin is driven to produce the expansive force.
- B. The pin shall be provided with a zinc sleeve with a mushroom-style head and stainless steel nail pin.
- C. Anchors shall be Zinc Nailon Anchors, manufactured by Simpson Strong-Tie, Inc., Metal Hit Anchors, manufactured by Hilti, Inc., Rawl Zamac Nailin, manufactured by the Rawlplug Company, or approved equal.

PART 3 EXECUTION

3.01 FABRICATION AND INSTALLATION REQUIREMENTS

- A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

3.02 WELDING

- A. Method:
 1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.
 2. The qualification of the welders shall be in accordance with the AWS Standards.
- B. Quality:
 1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.
 2. Weld reinforcement shall be as indicated by the AWS Code.
 3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
 4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.
 5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.03 GALVANIZING

- A. Structural steel plate's shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.
- B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.
- C. Bolts, anchor rods, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- D. Field Repairs
 - 1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.
 - 2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
 - 3. The coating shall be applied to at least 3 mils dry film thickness, and shall be Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide, or equal.

3.04 DRILLED ANCHORS

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.
- C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.
- E. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars.
- F. All abandoned drilled holes shall be filled with Epoxy Anchor Grout.

END OF SECTION

SECTION 05 52 13 PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Aluminum bar stock railings.

1.02 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.
- D. Qualification Data: For qualified professional Engineer.
- E. Welding certificates.
- F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive Engineering analysis by a qualified professional Engineer, using performance requirements and design criteria indicated.
- B. General: In Engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
 - 2. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.06 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 PRODUCTS

2.01 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.02 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Alloys and tempers in first six paragraphs below are typical for products listed when used in railings; revise to suit structural performance requirements.
- C. Yield strength for Alloy 6063-T5/T52 is 15 to 16 ksi (105 to 110 MPa).
- D. Extruded Bars and Tubing: ASTM B 221, Alloy 6063-T5/T52.
- E. Yield strength for Alloy 6063-T6 is 25 ksi (172 MPa).
- F. Yield strength for Alloy 6061-T6 is 32 to 35 ksi (220 to 240 MPa). Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- G. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.
- H. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.03 FASTENERS

- A. General:
 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
 2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
 3. Aluminum Railings: Type 316 stainless-steel fasteners.

- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.

2.04 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.05 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the 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.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 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 flux immediately.
 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
 - J. Non-welded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
 - K. Form changes in direction as follows:
 1. By flush bends.
 - L. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
 - M. Close exposed ends of railing members with prefabricated end fittings.
 - N. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
 - O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
 - P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.06 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.07 ALUMINUM FINISHES

- A. Mechanical Finish: AA-M12 (Mechanical Finish: nonspecular as fabricated).
- B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther 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, and locate joint within 6 inches of post.

3.04 ATTACHING RAILINGS

- A. Attach railings to wall with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with predrilled hole for exposed bolt anchorage.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- B. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

3.05 ADJUSTING AND CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.06 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

SECTION 05 53 00 GRATINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes metal bar gratings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 15 00 - Concrete Accessories
- B. Section 03 30 00 - Cast-in-Place Concrete
- C. Section 05 12 00 - Structural Steel Framing

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AWS D1.1/D1.1M - Structural Welding Code - Steel
 - 2. AWS D1.2/D1.2M - Structural Welding Code - Aluminum
 - 3. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel
 - 4. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel
 - 5. NAAMM MBG 531 - Metal Bar Grating Manual
 - 6. NAAMM MBG 532 - Heavy-Duty Metal Bar Grating Manual.

1.04 DESIGN CRITERIA

- A. Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniformly distributed load of 150 lbs / sft or concentrated load of 2000 lb-f , whichever produces the greater stress.
 - 2. Maximum allowable deflection is 1/4 inch with 150 lbs / sft uniformly distributed load or 500 lbs concentrated load applied at midspan.
- B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

1.05 REQUIREMENTS OF REGULATORY AGENCIES

- A. The latest Federal OSHA Standards, as adopted by the State of Michigan, and as they relate to gratings shall apply to the Work of this specification where applicable.
- B. Expansion anchor bolts shall meet federal and state OSHA requirements for pull-out and shear.

1.06 SUBMITTALS

- A. Submit shop drawings showing layout, fabrication dimensions, anchoring details and erection information. Also include attachments to other work and paint products.
- B. Fabrication and/or erection of items done prior to Engineer review of shop drawing shall be at the risk and expense of the Contractor.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.
- D. When requested by the Engineer, submit mill or laboratory certified copies of testing reporting chemical analysis and physical property of metal used in fabrication of items of this Section.

- E. Submit affidavits when requested by the Engineer, certifying that the grating capacities comply with the requirements as specified and indicated in this Section or on the Plans.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver miscellaneous metal items in an undamaged condition. Damaged items shall be repaired or replaced to the satisfaction of the Owner at the expense of the Contractor.
- B. Store items to permit easy access for inspection and identification. Keep items off the ground, using pallets, platforms, or other supports. Protect unpackaged and packaged items from erosion and deterioration of shop paint or finish surface.
- C. Do not store on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replacement shall be to the satisfaction of the Owner at the expense of the Contractor.

1.08 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1.09 PROTECTION

- A. Installed anchor bolts, inserts and other miscellaneous metal items shall be protected while other Work is being performed. Installed items that are damaged shall be repaired or replaced at the Contractor's expense.

1.10 SEQUENCING

- A. Anchors, frames, or other miscellaneous metal items to be embedded in concrete shall be provided on site as required for uninterrupted construction sequence.

1.11 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.01 FERROUS METALS

- A. Steel Shapes, Plates or Bars: ASTM A36/A36M
- B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.
- D. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30 (Grade 205).
- E. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.
- F. Type 316 stainless steel is more corrosion resistant and more expensive than Type 304.
- G. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304.
- H. Stainless-Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- I. Expanded-Metal Stainless Steel: ASTM F1267 , Class 3, made from stainless-steel sheet, ASTM A666, Type 304.

2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless steel fasteners for fastening stainless steel.
- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group (1) A1.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563/A563M; and, where indicated, flat washers.
- D. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Plain Washers: Round, ASME B18.22M.
- F. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
- G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- H. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
- I. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group (1) A1 stainless-steel bolts, ASTM F593 and nuts, ASTM F594.

2.03 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M .

2.04 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and 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.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
 2. Fabricate toeplates for attaching in the field.
 3. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.
 4. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) o.c.
 5. Bearing Bar Depth: As required to comply with structural performance requirements.
 6. Bearing Bar Thickness: As required to comply with structural performance requirements.
 7. Crossbar Spacing: 4 inches (102 mm) o.c.
 8. Traffic Surface: Serrated.
 9. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.
- G. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
1. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) o.c.
 2. Bearing Bar Depth: As required to comply with structural performance requirements.
 3. Bearing Bar Thickness: As required to comply with structural performance requirements.
 4. Crossbar Spacing: 4 inches (102 mm) o.c.
 5. Traffic Surface: Serrated.
 6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.
- H. Pressure-Locked, Stainless-Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
1. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) o.c.
 2. Bearing Bar Depth: As required to comply with structural performance requirements.
 3. Bearing Bar Thickness: As required to comply with structural performance requirements.
 4. Crossbar Spacing: 4 inches (102 mm) o.c.
 5. Traffic Surface: Serrated.
 6. Finish: Abrasive blasted.
- I. Pressure-Locked, Rectangular Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
1. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) o.c.
 2. Bearing Bar Depth: As required to comply with structural performance requirements.
 3. Bearing Bar Thickness: As required to comply with structural performance requirements.
 4. Crossbar Spacing: 4 inches (102 mm) o.c.
 5. Traffic Surface: Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.

6. Aluminum Finish: Mill finish.
- J. Pressure-Locked, Aluminum I-Bar Grating: Fabricated by swaging crossbars between bearing bars.
 1. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) o.c.
 2. Bearing Bar Depth: As required to comply with structural performance requirements.
 3. Bearing Bar Flange Width: 1/4 inch (6.4 mm).
 4. Crossbar Spacing: 4 inches (102 mm) o.c.
 5. Traffic Surface: Grooved.
 6. Aluminum Finish: Mill finish.
- K. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
 2. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
 3. Furnish threaded bolts with nuts and washers for securing grating to supports.
- L. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- M. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- N. Do not notch bearing bars at supports to maintain elevation.

2.05 STEEL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish gratings, frames, and supports after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2.06 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. All American Grating.
 2. Fisher & Ludlow; a NUCOR Company.
 3. Ohio Gratings, Inc.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

- B. Provide temporary bracing or anchors in form work for items that are to be built into concrete or masonry.
- C. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- D. Attach toeplates to gratings by welding at locations indicated.
- E. 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.
- F. 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.

3.02 INSTALLATION OF METAL BAR GRATING

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach 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 nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

END OF SECTION

SECTION 07 10 00 DAMPPROOFING AND WATERPROOFING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes furnishing and applying thermal and moisture protection for the surfaces of structures constructed under this Contract, as indicated on the plans, including perimeter insulation, vapor barriers and damp proofing.

1.02 SUBMITTALS

- A. Submit manufacturer's literature of proposed products for review by the Engineer in accordance with Section 01 33 00 - Submittal Procedures.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Unload and store in accordance with manufacturer's recommendations.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. The temperature of the ambient air, surface and material during installation shall be in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 PERIMETER INSULATION

- A. Use multi-cellular board of extruded polystyrene foam with a minimum thickness of 2-inches, unless otherwise shown on the Plans, conforming to ASTM C578, Type IV:
 - 1. Minimum compressive strength: 18 psi
 - 2. Maximum water vapor transmission: 1.1 U.S. perm per inch
 - 3. Thermal resistance: 5.0 F-sft-hr/Bt

2.02 VAPOR BARRIER

- A. Use a 6 mil, polyethylene film.

2.03 DAMP PROOFING

- A. Use bituminous base for below grade surfaces and colorless, transparent nonstaining silicone compound for above grade surfaces.

2.04 CRYSTALLINE WATERPROOFING

- A. A cementitious crystalline type waterproofing material consisting of portland cement, silica sand and chemicals which chemically controls and permanently fixes non-soluble crystalline growth throughout the capillary voids of the concrete.

2.05 ACCEPTABLE MANUFACTURERS

- A. Perimeter Insulation
 - 1. Dow "Styrofoam"
 - 2. United States Gypsum Company "Formula R"
 - 3. Engineer approved equal.
- B. Vapor Barrier
 - 1. Polyamerica "Visqueen"
 - 2. ADPI Enterprises, Inc. "Durethene"

3. Engineer approved equal.
- C. Crystalline Waterproofing:
 1. Xypex Concentrate
 2. Engineer approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Subgrade surfaces shall be smooth, free from voids, and sharp projections, and shall be to the lines and grades indicated on the Plans before vapor barrier, perimeter insulation, damp proofing, or waterproofing is installed.
- B. Prior to damp proofing or waterproofing, fill and finish flush with Portland cement mortar any cracks, holes, cavities or other surface defects.
- C. Clean surfaces of all dirt, dust, scale, laitance, curing compounds, oil, grease or other foreign material. Surfaces shall be dry and structurally sound. Apply grout coat of mortar to portions of

3.02 INSTALLATION OF PERIMETER INSULATION

- A. Provide on foundation walls or under slabs as indicated on the Plans. Install and attach to walls as recommended by the manufacturer.

3.03 INSTALLATION OF VAPOR BARRIER

- A. Provide under all floor slabs on subgrade as indicated on the Plans.
- B. Use widest practical, seamless width. Use 6 inch minimum laps with top lap placed in direction of concrete placement.
- C. Use extreme care in placing concrete reinforcement so as to not disturb or damage vapor barrier.
- D. Do not penetrate with stakes, concrete reinforcement or supports. Seal openings with tape in accordance with manufacturer's recommendations prior to concrete placement.

3.04 INSTALLATION OF DAMP PROOFING

- A. Provide on the wet, exposed or backfilled side of all walls or slabs with wet, exposed-to-weather or backfill on one side and dry on the other side as indicated on the Plans.
- B. On backfilled surfaces use two (2) coats each applied at a rate of not less than 1 gal per 100 square feet in accordance with manufacturer's recommendations. Use care to not permit material to get on any exposed surfaces. Remove such spillage or misapplication immediately. Allow material to thoroughly dry between coats and after final application.
- C. On exposed surfaces use two (2) coats each applied at a rate of not less than 1 gal per 200 square feet in accordance with manufacturer's recommendations. Do not stain or discolor surfaces or allow runs or waves in applied material.

3.05 INSTALLATION OF CRYSTALLINE WATERPROOFING

- A. Crystalline waterproofing shall be applied to green concrete or existing concrete which has been thoroughly saturated with clean water. Surfaces to be treated shall be moistened prior to application as required to insure proper migration of chemicals into the capillary voids in the concrete.
- B. Waterproofing material shall be mixed by volume with clean water which is free from salt or other deleterious materials. Waterproofing material shall be mixed in accordance with manufacturer's instructions.

- C. After repairs, patching and sealing has been done in accordance with manufacturers requirements, the concrete surfaces shall have a slurry of crystalline waterproofing applied in two coats at a rate of 1.5 lbs per square yard per coat.
- D. Curing shall begin as soon as the waterproofing material has set up. Treated surfaces shall be fog sprayed three times a day for a three day period, or may be covered with damp burlap for three days.
- E. Crystalline Waterproofing may also be applied by mixing an approved admixture into the fresh concrete, according to the manufacturer's directions, at the time of placing concrete.

END OF SECTION

SECTION 07 92 00 JOINT SEALANTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Section covers sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.
- B. Section includes sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and non-traffic horizontal surfaces:
 - a. Control and expansion joints in unit masonry or concrete.
 - b. Perimeter joints between materials listed above and frames of doors and windows.
 - c. Other joints as indicated.
 - 2. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - d. Joints on underside of precast beams and planks.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - g. Other joints as indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 - Cast-in-Place Concrete
- B. Section 03 41 00 - Precast Concrete

1.03 REFERENCE STANDARDS

- A. ASTM C509 - Elastomeric Cellular Preformed Gasket and Sealing Material.
- B. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- C. ASTM C717 - Standard Terminology of Building Seals and Sealants.
- D. ASTM C834 - Latex Sealants.
- E. ASTM C919 - Use of Sealants in Acoustical Applications.
- F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- H. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 - Submittal Procedures.
- B. Product Data: For each type of product.

- C. Samples for Verification: For each type and color of joint sealant required. Install joint sealants in 1/2-inch wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 COORDINATION

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
 - 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees Fahrenheit (4.4 degrees Celsius).
 - 3. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.09 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Installer's Warranty: Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- C. Special Manufacturer's Warranty: Written warranty, signed by elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that do

not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.
- D. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.
- C. Joint sealant used in concrete water storage tanks or otherwise in contact with potable water shall be NSF 61 approved.

2.02 MATERIALS

- A. Compatibility: Provide joint sealants, backings, 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.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.
- C. Approvals: Joint sealant and other materials used in concrete water storage tanks or otherwise in contact with potable water shall be NSF 61 approved.

2.03 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Comply with ASTM C920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C920 classifications for type, grade, class, and uses.
- B. Stain-Test Response Characteristics: Where elastomeric sealants are specified in Elastomeric Joint Sealant Schedule to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C1248 and have not stained porous joint substrates indicated for Project.

2.04 LATEX JOINT SEALANTS

- A. Latex Sealant Standard: Comply with ASTM C834 for each product of this description indicated in the Latex Joint-Sealant Schedule at the end of Part 3.

2.05 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that 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. Cylindrical Sealant Backings: ASTM C1330 , of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 degrees Fahrenheit (minus 32 degrees Celsius). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape 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: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
 - 1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean 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 sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.

4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - a. Metal.
 - b. Glass.
 - c. Glazed surfaces of ceramic tile.
5. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
6. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that 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.

3.03 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses provided for each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealants from surfaces adjacent to joint.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint configuration per Figure 5A in ASTM C1193, unless otherwise indicated.
 4. Provide flush joint configuration, per Figure 5B in ASTM C1193, where indicated.

5. Provide recessed joint configuration, per Figure 5C in ASTM C1193 , of recess depth and at locations indicated.
- G. Use masking tape to protect adjacent surfaces of recessed tooled joints.

3.04 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as follows:
 1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each type of elastomeric sealant and joint substrate.
- B. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 1. Test Method: Test joint sealants by hand-pull method described below:
 - a. Make knife cuts from one side of joint to the other, followed by two cuts approximately 2 inches (50 mm) long at sides of joint and meeting crosscut at one end. Place a mark 1-inch (25 mm) from cross-cut end of 2-inch (50-mm) piece.
- C. Use fingers to grasp 2-inch (50-mm) piece of sealant between cross-cut end and 1-inch (25-mm) mark; pull firmly at a 90-degree angle or more in direction of side cuts while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
- D. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
 1. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
 2. Inspect tested joints and report on the following:
 - a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field- adhesion hand-pull test criteria.
 - b. Whether sealants filled joint cavities and are free from voids.
 - c. Whether sealant dimensions and configurations comply with specified requirements.
 3. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 4. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- E. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion.
- B. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.07 ELASTOMERIC JOINT-SEALANT SCHEDULE

- A. Multicomponent Nonsag Polysulfide Sealant; Where joint sealants of this type are indicated, provide products complying with the following:
 - 1. Products: Available products include the following:
 - a. CM-60; W.R Meadows, Inc.
 - b. T-2235-M; Morton International, Inc.
 - c. T-2282; Morton International, Inc.
 - d. Thiokol 2P; Morton International, Inc.
 - e. GC-5 Synthacalk; Pecora Corporation.
 - f. Two-Part Sealant; Sonneborn Building Products Div., ChemRex Inc.
 - 2. Type and Grade: M (multicomponent) and NS (nonsag).
 - 3. Class: 25.
 - 4. Use Related to Exposure: NT (non-traffic).
 - 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Coated glass, galvanized steel, brick, ceramic tile, and wood.

3.08 LATEX JOINT-SEALANT SCHEDULE

- A. Latex Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
 - 1. Chem-Calk 600; Bostik Inc.
 - 2. NuFlex 330; NUCO Industries, Inc.
 - 3. LC 160 All Purpose Acrylic Caulk; Ohio Sealants, Inc.
 - 4. AC-20; Pecora Corporation.
 - 5. PSI-701; Polymeric Systems, Inc.
 - 6. Sonolac; Sonneborn Building Products Div., ChemRex, Inc.
 - 7. Tremflex 834; Tremco.

END OF SECTION

SECTION 08 31 13 ACCESS HATCHES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Access hatches shall be of single- or double-cover construction of the size and as shown on Drawings.

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Drawings for fabrication and installation of all floor, pit, and sidewalk doors and frames, including details of each frame type, elevations of door design types, anchorage, and accessory items.
 - 2. Product Data: Submit manufacturer's technical data and installation instructions for each type of access hatched assembly, including setting drawings, templates, and instructions and directions for installation of anchorage devices.
 - a. Include complete schedule including types, general locations, sizes, floor, pit, and sidewalk construction details, finishes, hardware information, latching or locking provisions, and other data pertinent to installation.
 - 3. Verification: Obtain specific locations and sizes for access hatches from trades and manufacturers requiring access to equipment, and indicate on Submittal Schedule.
 - 4. Special Size and Load Floor, Pit, and Sidewalk Doors: Use where required or requested as indicated on Drawing Schedule.
 - 5. Samples: 3 inches by 5 inches minimum size, of each cover face material showing factory finished color, pattern, and texture.
- B. Submittals Sequence: Submit Schedule, Product Data, and Shop Drawings at earliest possible date, particularly where acceptance must precede fabrication of other work (e.g., concrete work) which is critical in the Project Construction Schedule. Include the product data, samples, Shop Drawings of other work affected by access hatches, and other information essential to the coordinated review of same.

1.03 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide access hatches, frames, hardware, and related items produced by a single manufacturer capable of showing prior production of floor access hatches assemblies similar to those required.
- B. 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.
- C. Size Variations: Obtain Engineer's acceptance of manufacturer's standard size units which may vary slightly from sizes indicated.
- D. Coordination: Provide inserts and anchoring devices which must be built into other Work for installation of access hatches. Coordinate delivery with other Work to avoid delay.

1.04 PROJECT CONDITIONS

- A. Field Measurement: Where possible, field measure openings before fabrication to ensure proper fit of work; show measurements on final Shop Drawings. Coordinate fabrication with construction progress to avoid delay. If necessary, proceed with fabrication without measurements, and coordinate tolerances to ensure proper fit.

1.05 WARRANTIES

- A. Special Warranty: Submit a written warranty, executed by the manufacturer, agreeing to repair or replace components or entire units which fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to, structural failure including excessive deflection, excessive water leakage, faulty operation of hardware, deterioration of metals, metal finishes and other materials beyond normal weathering.
 - 1. Warranty period for access hatch units shall be 5 years after the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Bilco
 - 2. Halliday
 - 3. USF Fabrication

2.02 MATERIALS

- A. Provide each access hatch assembly manufactured as an integral unit, complete with all parts and ready for installation.
- B. Aluminum access hatches and frames: Fabricate units of continuous welded aluminum construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure frames to types of floor or walkway shown on Drawings.
- C. Covers: Covers shall be mill finish aluminum 1/4-inch diamond pattern, reinforced on the underside. Covers shall open to 90 degrees and lock automatically in that position.
- D. Channel Frame: Channel frame shall be 1/4-inch extruded aluminum with bituminous coating applied to the exterior of the frame and with full anchor flange and welded anchors for concrete installation around the perimeter.
- E. For watertightness, furnish frame with formed gutters a minimum of 3-inch wide by 3-inch deep, anchors, and a welded 1-1/2-inch drain coupling located on the right front corner of the channel frame or in another corner if shown on Drawings or specified otherwise. Fully weld gutter frame for absolute weathertightness.
- F. Hinges, Pins, Bolts, and Nuts: Provide the covers with heavy 12 gauge, No. 316 stainless steel hinges and stainless steel pins. Hinges shall pivot so the cover does not protrude into channel frame. Hinges shall be through-bolted to the cover with stainless steel lock bolts and shall be through-bolted to the frame with stainless steel bolts and lock nuts.
- G. Springs, Tubes, Shoes, Plates, Enclosures, and Operators: Provide the covers with manufacturer's standard springs, tubes and caps, tube or spring enclosures, operators, support plates, and shoes, which shall allow ease of operation through the entire 90-degree arc of opening, and act as a check in retarding downward motion when being closed. Tube and spring enclosures shall prevent accumulation of moisture, grit, and debris inside the tube and spring assembly.
- H. Hold-Open Arms: Provide the covers with hold-open arms with guides which automatically lock the covers in the open position. Vinyl covered release handles shall be provided and conveniently located for closing.
- I. Interior Snap Lock and Lock Strike: Provide a stainless steel snap lock and lock strike with a stainless steel fixed turn handle and appropriate stainless steel bolts mounted on the underside of the covers.

- J. Exterior Lift Handle: Provide the covers with a stainless steel lift handle designed to be flush with walking surface when not in use.
- K. Locking and Latching Devices: Provide the covers with the following locking or latching device and related hinged lid, flush gasketed removable screw plug, or threaded cover plug as noted:
- L. Interior access hatches shall have removable exterior latch handle with plug: Provide removable exterior stainless steel latch handle and latch release protected by a flush gasketed removable screw plug.
- M. Exterior access hatches shall have cylinder lock: Provide a brass cylinder lock with keyway protected by a threaded cover plug. Equip lock with cylinder and keys as specified.
- N. Hardware Finish: Except where noted otherwise, all hardware shall be zinc plated and chromate sealed.

2.03 ACCESSORIES

- A. Provide ladder safety posts at fixed ladders and manhole rungs located below access hatches. Safety posts shall be designed with telescoping section that locks automatically when fully extended. Up and down movement shall be controlled by a stainless steel spring balancing mechanism. Unit shall be completely assembled with fasteners for securing to ladder rungs in accordance with manufacturer's instructions. Finish to match ladder served.
 - 1. Safety post shall be Bilco Ladder Up or approved equal.
- B. Provide fall prevention device below floor doors. The fall prevention device shall be permanently installed fall-through prevention system that is easily retractable for full access and allows visibility for inspection. The product must be FRP or stainless steel Type 316. Grating shall have a live load capacity of 100 pounds per square foot.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's instructions for installation of floor, pit, and sidewalk doors.
- B. Preparatory Work: For normal flush installation, set frames accurately in position, recessed below the finished grade or floor level with cover face panels plumb or level in relationship to adjacent finish surfaces. If unit is watertight type, unit should be set with slight pitch in direction of drain coupling. All four corners of the frame shall be in the same plane; verify that leaves are seated properly on frame all around. Securely attach units to supports.
- C. Method: For flush installation, pour concrete to top of frame. Aluminum surfaces in contact with concrete shall be coated with a bituminous coating prior to installation.
- D. Coordinate installation with Work of other trades.

3.02 ADJUSTING AND CLEANING

- A. Adjust hardware and covers after installation for proper operation.
- B. Remove and replace covers or frames which are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 09 10 00 PIPING IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish, mark, and install identification devices for exposed piping and piping in accessible chases and areas above ceilings with panels, and valves using color bands, lettering, flow direction arrows, and related permanent identification devices, and appurtenant works, in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 09 96 00 - Industrial Paints and Coatings
- C. Division 23 - Heating, Ventilating, and Air-Conditioning
- D. Division 26 - Electrical
- E. Division 40 - Process Integration
- F. Division 41 - Material Processing and Handling Equipment
- G. Division 42 - Process Heating, Cooling, and Drying Equipment
- H. Division 43 - Process Gas/Liquid Handling, Purification, & Storage Equipment
- I. Division 44 - Pollution Control Equipment

1.03 SUBMITTALS

- A. In accordance with Section 01 33 00, Contractor shall submit samples of all types of identification devices to be used in the work. Contractor shall also submit to Engineer, for approval, a list of suggested wording for all valve tags prior to fabrication.

PART 2 PRODUCTS

2.01 IDENTIFICATION OF PIPING

- A. Exposed piping, piping in accessible chases, and piping in areas above ceilings with panels, shall be completely and totally painted for identification purposes.
 - 1. Piping shall be identified with lettering or tags designating the service of each piping system, shall have flow directional arrows, and shall be completely painted and color coded as scheduled below.
 - 2. Piping scheduled to be color coded shall be completely painted or coated with the indicated colors.
- B. Each pipe identification shall consist of the following:
 - 1. Color coding in accordance with the Piping Identification Schedule;
 - 2. A painted label; and
 - 3. A directional flow arrow.
- C. The painted label and directional arrow shall be placed between color bands. When more than one color band is used the different color bands shall be painted adjacent. Piping identification shall be located in accordance with Article 3.03 of this Section.
- D. Color Bands and Arrows:
 - 1. Pipe color bands shall be painted on the pipe. Paper or plastic banding of pipe shall not be acceptable.

- E. Arrows shall be of the same color as the lettering and shall point away from the lettered labels in the direction of the flow.

1. Color band size shall be as follows:

Pipe Size (Outside Diameter)	Color Band Width
< 1"	1"
1" – 12"	1 pipe diameter
> 12"	12"

- F. Lettering:

- Contents identification labels shall be stenciled directly on pipes.
- Black identification letters shall be used where the background pipe color is light, and white identification letters where the background color is dark.
- The size of the letters for identification labels shall be as follows:

Pipe Size (Outside Diameter)	Letter Size
5/8" – 1"	5/16" high
1" – 3"	3/4" high
> 3"	2"

2.02 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, Contractor shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves and appurtenances to the level specified herein.

2.03 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

2.04 IDENTIFICATION OF PIPE 5/8 INCH OR SMALLER

- A. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, metal tags shall be provided instead of lettering.
- B. Tags shall have the specified identifying lettering stamped in the tag and shall be fastened to the pipe with suitable chains.
- C. Metal tags and chains shall be aluminum or stainless steel.
- D. Where tags are used, pipe shall be color coded as specified in this Section.

2.05 MISCELLANEOUS

- A. Electrical conduit shall be painted to match ceiling or wall surfaces as directed by Engineer.
- B. Vent lines shall be painted to match the surfaces that they adjoin.
- C. Valve handwheels and levers shall be painted red.
- D. Hoist hooks and blocks shall be painted yellow with black stripes.

PART 3 EXECUTION

3.01 GENERAL

- A. Labels and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. Tags or labels shall be readily visible from all normal working locations.

3.02 VALVE TAGS

- A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.03 PIPE IDENTIFICATION LOCATION

- A. Straight lines of pipe shall be identified at intervals of 30 feet maximum, and at least once in each room unless otherwise directed by Engineer.
- B. Piping shall also be identified at a point approximately within 2 feet of turns, ells, valves, and on the upstream side of distribution fittings or branches and on both sides of each floor, wall or barrier through which the line passes.
- C. For pipe runs of 50 feet or less the distance between bands shall be 30 inches. For pipe runs of 50 feet or more, spacing between bands shall be 72 inches.
- D. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

3.04 IDENTIFICATION SCHEDULE

- A. Application of identifying devices shall conform to the following color codes or match existing color code as directed by Engineer.

Type of Service	Pipe Color / Strip Color
<i>Domestic Water</i>	
Potable Water (RP Device)	Light Blue
Fresh Water (Air Gap)	Light Blue
<i>Industrial and/or Cooling Water</i>	
LPE	Dark Blue/Red
MPE	Dark Blue/Red
HPE	Dark Blue/Red
HPE (continuously chlorinated)	Dark Blue/Red/Yellow
Fire Water	Red
Industrial Water	Dark Blue
Type of Service	Pipe Color / Strip Color
Cooling Water Supply-Plant Effluent	Dark Blue/Red
Cooling Water Return-Plant Effluent	Dark Blue/Red
Cooling Water Return-Industrial Water	Dark Blue
Cooling Water Supply-Industrial Water	Dark Blue
Reclaimed Water	Purple
Final Effluent	Dark Blue/Red
Irrigation (continuously chlorinated eff.)	Dark Blue/Red/Yellow
<i>Chemical Supply Lines (Extremely Dangerous)</i>	
Chlorine (gas or liquid)	Yellow
Chlorine Solution	Yellow
Sodium Hydroxide	Yellow

Chlorinator Vent and Detection Lines	Yellow
Hydrazine	Yellow
Lime Slurry	Yellow
Sodium Hypochlorite	Yellow
Ferric Chloride	Yellow
Ferrous Chloride	Yellow
Phosphoric Acid	Yellow
Concentrated Sulfuric Acid	Yellow
Dilute Sulfuric Acid	Yellow
Chemical Draw and Vent	same color as the chemical line
Dilute Acid	Yellow
Chemical Supply Lines	
Anionic Polymer	White/Yellow
Cationic Polymer	White/Yellow
Nonionic Polymer	White/Yellow
Chemical Draw and Vent	same color as the chemical line
Sulfite/Bisulfite Scrubbing Liquid	White/Yellow
Stratford Solution (Scrubbing Liquor)	White/Yellow
Sludge/Ash Transport and Process Lines	
Blended Sludge	Dark Brown
Bottom Sludge	Dark Brown
Centrate (from digested sludge dewatering)	Dark Brown/Dark Blue
Centrate (H ₂ S Scrubbing)	White/Yellow
Circulated Sludge	Dark Brown
Digested Sludge	Dark Brown
Sulfur Slurry (H ₂ S Scrubber)	Dark Brown
Sludge/Ash Transport and Process Lines	
Sludge Filtrate Dark	Brown/Dark Blue
Raw Sludge	Dark Brown
Screened Digested Sludge	Dark Brown
Waste Activated Sludge	Light Brown
Digester Cleanings	Dark Brown
Digested Sludge to Screenings	Dark Brown
Digested Sludge to Blending Tanks	Dark Brown
Digested Sludge Recirculated/Transfer	Dark Brown
Digested Sludge Withdrawal	Dark Brown
Thickened Waste Activated Sludge	Light Brown
Return Activated Sludge	Light Brown
Thickener Subnatant Light	Brown/Dark Blue
Thickener Subnatant Overflow	Light Brown/Dark Blue
Cyclone Effluent	Dark Brown/Dark Blue
Grit	Dark Brown
Mixed Liquor	Light Brown
Thickener Pressurized Recycle	Light Brown/Dark Blue
Scum	Dark Brown
Ash (hydraulic)	Light Brown

Processed Condensate	Dark Blue/Light Brown
Process Effluent	Dark Blue/Red
Final Clarifier Influent	Light Brown
<i>Pneumatic Transport Lines</i>	
Sludge Derived Fuel	Light Green/Orange
Hot Ash	Light Green/Yellow
Sand Transport	Light Green
<i>Air and Vacuum Supply Lines</i>	
Oxygen (gaseous)	Purple/Black
Oxygen (liquid)	Purple/Black
Combustion Air	Green
Compressed Air (non-instrument)	Green/Red
<i>Air and Vacuum Supply Lines</i>	
Instrument Air	Green/White
Process Air	Green
Product Air	Green/Light Green
Foul Air	Green/Grey
Nitrogen (liquid)	Green/Black
Nitrogen (gaseous)	Green/Black
Vacuum	Green
Vent Duct	same as line color
<i>Boiler Waters</i>	
Boiler Feedwater Makeup	Dark Blue/Orange
Boiler Feedwater	Dark Blue/Orange
Continuous Blow-down	Dark Blue/Orange
Demineralized Water	Dark Blue/Orange
H. P. Condensate	Dark Blue/Orange
L. P. Condensate	Dark Blue/Orange
M. P. Condensate	Dark Blue/Orange
Intermittent Blow-down	Dark Blue/Orange
Softened Water Dark	Blue/Yellow
Type of Service	Pipe Color / Strip Color
Reverse Osmosis Treated Water (permeate)	Dark Blue/Orange
<i>Steam</i>	
Low-pressure Steam	Orange/Red
Medium-pressure Steam	Orange/Red
High-pressure Steam	Orange/Red
<i>Lube and Hydraulic Oils</i>	
Hydraulic Oil Supply	White/Orange
Hydraulic Oil Return	White/Orange
Lube Oil	White/Orange
Drain Oil	White/Orange
Oil Vapor	White/Orange
Grease	White/Orange
Defoamant-Sludge Blending Tanks (Kerosene)	White/Orange
<i>Fuel Supply</i>	

Natural Gas/LNG/Propane	Orange
Digester Gas: LP, MP, and HP	Orange
Diesel	Orange
Laboratory	
Distilled Water	Dark Blue/Orange
Miscellaneous	
Equipment Vent	same as equipment
Sample Line	same as line or equipment being sampled
Spare Chemical	same as chemical
Sanitary Sewer/Storm Drains	
Roof Drain	Black or same color as bldg walls
Plant Drain	Black
Storm Drain	Black
Sump Pump Discharge	Black
Sanitary Sewer	Black
Sanitary Vent	Black
Influent Raw Sewage (up to primary tanks)	Grey
Demineralized Waste	Black/Yellow
Reverse Osmosis Reject	Black

END OF SECTION

SECTION 09 96 00 INDUSTRIAL PAINTS AND COATINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Surface preparation and field application of paints and coatings.
- B. New surfaces and construction shall be painted. Existing surfaces and areas shall be painted as called for on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 60 00 - Product Requirements
- C. Section 09 10 00 - Piping Identification Systems

1.03 REFERENCE STANDARDS

- A. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
- B. AWWA (American Water Works Association) - D102-17 - Painting Steel Water Storage Tanks.
- C. International Concrete Repair Institute (ICRI) Guideline No. 310.2-R2013 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
- D. NACE (NACE International) -Industrial Maintenance Painting.
- E. SSPC (SSPC: The Society for Protective Coatings) SSPC Painting Manual Volumes 1 and 2.
- F. NAPF (National Association of Pipe Fabricators) Section 500 Surface Preparation Standards.

1.04 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 - Submittal Procedures.
 - 1. Coating Materials List: Contractor shall provide six (6) copies of a coating materials list which indicates the manufacturer and the coating number, keyed to the coating schedule herein, for approval of Engineer. Submittals shall be made sufficiently in advance of the coating operations to allow ample time for checking, correcting, resubmitting and rechecking.
 - 2. Paint Manufacturer's Information: For each paint system to be used, Contractor shall submit the following listed data prior to beginning painting operations.
 - a. Paint manufacturer's data sheet for each product used.
 - b. Paint manufacturer's instructions and recommendations on surface preparation and application.
 - c. Colors available for each product (where applicable).
 - d. Compatibility of shop and field applied coatings (where applicable).
 - e. Material safety data sheet for each product used.
- B. Selection Samples: Submit a complete set of color chips that represent the full range of manufactures color samples available.
- C. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen. Minimum sample size shall be 6 inch square.

1.06 MOCK-UP

- A. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish surfaces for verification of products, colors, & sheens.
 - 2. Finish area designated by Engineer.
 - 3. Provide samples that designate prime and finish coats.
 - 4. Do not proceed with remaining work until Engineer approves the mock-up samples.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information:
 - 1. Product name, type (description)
 - 2. Application and use instructions
 - 3. Surface preparation
 - 4. VOC content for two-component products; provide mixed VOC in g/L
 - 5. Environmental issues
 - 6. Batch date
 - 7. Color number
- B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.
- C. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

1.08 QUALITY ASSURANCE

- A. General:
 - 1. Contractor shall give Engineer a minimum of 3 days advance notice of the start of any field surface preparation work of coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.
 - 2. All such work shall be performed only in the presence of Engineer, unless Engineer has granted prior approval to perform such work in its absence.
 - 3. Inspection by Engineer, or the waiver of inspection of any particular portion of the work, shall not relieve Contractor of Contractor's responsibility to perform the work in accordance with these Specifications.
 - 4. Where protective coatings are to be performed by a subcontractor, said subcontractor must provide 5 references which show that the painting subcontractor has previous successful experience with the specified or comparable coating systems.
 - 5. Include the name, address, and the telephone number for the owner of each installation for which the painting subcontractor provided the protective coating.
- B. Scaffolding:
 - 1. Scaffold shall be erected and moved to locations where requested by Engineer to facilitate inspection. Additional illumination shall be provided to cover all areas to be inspected.
- C. Inspection Devices:

1. Contractor shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings.
2. Dry-film thickness gages shall be made available for Engineer's use at all times while coating is being done, until final acceptance of such coatings.

D. Holiday Testing:

1. Contractor shall holiday test all coated ferrous surfaces inside a steel reservoir, or other surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Areas which contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested.
2. Coatings With Thickness Exceeding 20 Mils:
 - a. For surfaces having a total dry film coating thickness exceeding 20 mils a pulse-type holiday detector shall be used.
 - b. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
3. Coatings With Thickness of 20 Mils or Less:
 - a. For surfaces having a total dry film coating thickness of 20 mils or less a non-destructive type holiday detector shall be used.
 - b. The unit shall operate at less than 75 volts.
 - c. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent shall be added to the water prior to wetting the detector sponge.
4. Contractor shall provide the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of Engineer.

E. Film Thickness Testing:

- a. On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage.
- b. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating.
- c. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gage.

F. Surface Preparation:

1. Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standard TM-01-70.

1.09 MANUFACTURER REPRESENTATIVE

- A. Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as specified in the paragraph entitled "Manufacturer's Certification", herein, and as may be necessary to resolve field problems attributable or associated with the manufacturer's products furnished under this Contract or the application thereof.

1.10 MAINTENANCE

A. Warranty Inspection:

1. A warranty inspection may be conducted during the eleventh month following completion of coating and painting work. Contractor and a representative of the coating material manufacturer shall attend this inspection.
2. Defective work shall be repaired in accordance with these specifications and to the satisfaction of Owner.
3. Owner may, by written notice to Contractor, reschedule the warranty inspection, or may cancel the warranty inspection altogether. If a warranty inspection is not held Contractor is not relieved of Contractor's responsibilities under the Contract Documents.

1.11 PROJECT CONDITIONS

- ### **A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not apply coatings under environmental conditions outside manufacturer's absolute limits.**

1.12 COORDINATION

- ### **A. Coordinate Work with other operations and installation of finish materials to avoid damage to installed materials.**
- ### **B. Do not apply coating materials until moisture-producing construction activities, dust-producing construction activities, and other construction activities which could impair performance or appearance of the coatings, have been completed.**

1.13 EXTRA MATERIALS

- ### **A. Supply for each finish coating material, color, and finish specified 2 gallons of coating material, in sealed 1 gallon containers, marked with color and finish identification.**
- ### **B. Custom Colors: Provide details of color formula and product availability for each finish specified.**

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- ### **A. Each of the following manufacturers is capable of supplying many of the industrial coating materials specified herein. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required.**
1. Ameron
 2. Carboline Coatings Company
 3. Engard Coatings Corporation
 4. Glidden Coatings and Resins
 5. ICI Paint Company
 6. Pittsburgh Paints
 7. Sherwin-Williams
 8. Tnemec Company
- ### **B. Substitutions:**
1. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00. When submitting request for substitution, provide complete product data specified above under Submittals, for each substitute product. Proposed substitute materials must

be shown to satisfy the material descriptions and to equal or exceed the properties of the listed materials.

2.02 MATERIALS

A. General:

1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not dilute or thin coatings, except as instructed.
2. Do not add additives, except as instructed or recommended by coating manufacturer.
3. For opaque finishes, tint each coat, including primer coat and intermediate coats, one-half shade darker than succeeding coat, with final finish coat as base color.
4. Supply each coating material in quantity required for this Section from a single production run.

B. Accessories:

1. Provide as required or as identified in the coating manufacturer's application instructions. Accessories include but are not limited to thinners, sealers, primers, cleaning agents, etching agents, cleaning cloths, sanding materials, and clean-up materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Ensure that surfaces to receive coatings are dry immediately prior to application.
- C. Ensure that moisture-retaining substrates to receive coatings have moisture content within tolerances allowed by coating manufacturer, using moisture measurement techniques recommended by coating manufacturer.
- D. Examine surfaces to receive coatings for surface imperfections and contaminants that could impair performance or appearance of coatings, including but not limited to, loose primer, rust, scale, oil, grease, mildew, algae, or fungus, stains or marks, cracks, indentations, or abrasions.
- E. Correct conditions that could impair performance or appearance of coatings in accordance with specified surface preparation procedures before proceeding with coating application.

3.02 PREPARATION

A. General:

1. Surfaces to receive protective coatings shall be cleaned as specified herein prior to application of said coatings. Contractor shall examine surfaces to be coated, and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application.
2. Remove stains and marks completely, if possible, using materials and methods recommended by coating manufacturer; cover stains and marks which cannot be completely removed with isolating primer or sealer recommended by coating manufacturer to prevent bleed-through.
3. Remove mildew, algae, and fungus using materials and methods recommended by coating manufacturer.
4. Remove dust and loose particulate matter from surfaces to receive coatings immediately prior to coating application.

5. Do not start work until surfaces to be finished are in proper condition to produce finished surfaces of uniform, satisfactory appearance.
- B. Protection of Surfaces Not to be Coated:
1. Surfaces which are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.
 2. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked or otherwise protected. The working parts of all mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.
 3. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces.
 4. Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. Contractor shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.
- C. Protection of Painted Surfaces:
1. Cleaning and coating shall be so programmed that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

3.03 SURFACE PREPARATION

- A. General:
1. Prepare surfaces in accordance with manufacturer's instructions for specified coatings and indicated materials, using only methods and materials recommended by coating manufacturer, and as follows:
- B. Existing Coatings:
1. Remove surface irregularities by scraping or sanding to produce uniform substrate for coating application; apply one coat primer of type recommended by coating manufacturer for maximum coating adhesion.
 2. If presence of lead in existing coatings is suspected, cease surface preparation of existing coating and notify Engineer immediately.
- C. Incompatible Coatings:
1. If coatings to be applied are not compatible with existing coatings Contractor shall apply intermediate coatings per the paint manufacturer's recommendation for the specified coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.
- D. Unknown Coatings:
1. Coatings of unknown composition shall be completely removed prior to application of new coatings.
- E. Concrete and Concrete Masonry:
1. Clean surfaces free of loose particles, sand, efflorescence, laitance, form oil, curing compounds, and other substances which could impair coating performance or appearance.
- F. Concrete Floors:

1. Remove contaminants which could impair coating performance or appearance, acid-etch, flush with clean water; verify alkaline-acid balance recommended by coating manufacturer; mechanically abrade surface, if required, to achieve medium-sandpaper texture.
- G. Restored Masonry Surfaces:
1. Clean surfaces free of loose particles, sand, efflorescence, laitance, cleaning compounds, and other substances that could impair coating performance or appearance.
- H. Ferrous Metals, Unprimed:
1. Remove rust or scale, if present, by wire brush cleaning, power tool cleaning, or sandblast cleaning; remove grease, oil, and other contaminants which could impair coating performance or appearance by solvent cleaning, with phosphoric-acid solution cleaning of welds, bolts and nuts; spot-prime repaired welds with specified primer.
- I. Ferrous Metals, Shop-Primed:
1. Remove loose primer and rust, if present, by scraping and sanding, feathering edges of cleaned areas to produce uniform flat surface; solvent-clean surfaces and spot-prime bare metal with specified primer, feathering edges to produce uniform flat surface.
- J. Non-Passivated Galvanized Steel:
1. Clean with a water-based industrial strength cleaner, followed by a clean water rinse; or wipe down surfaces using clean, lint-free cloths saturated with xylene or lacquer thinner; followed by wiping the surface dry using clean, lint-free cloths.
- K. Passivated Galvanized Steel:
1. Clean with a water-based industrial strength cleaner, and/or "Brush Blast" in accordance with SSPC-SP 7.
 2. After the surface has been prepared, apply recommended primer to a small area. Allow primer to cure for 7 days, and test adhesion using the "cross-hatch adhesion tape test" method in accordance with ASTM D3359. If the adhesion of the primer is positive, proceed with a recommended coating system for galvanized metal.
- L. Mill-Finish Aluminum:
1. Etch surfaces with a phosphoric acid-water solution, flush with clean water and allow to dry, before applying primer coat.
 2. An alternative to etching the surface is to clean using a water-based industrial cleaner.
- M. Copper:
1. Clean surfaces by pressurized steam, pressurized water, or solvent washing.
- N. Stainless Steel:
1. Clean surfaces by pressurized steam, pressurized water, or clean with a water-based industrial cleaner.
- O. Wood:
1. Seal knots, pitch streaks, and sap areas with sealer:
 - a. Interior: Duron Terminator 3 White Pigmented Shellac (DU1710222), or equal.
 - b. Exterior: Duron Dura Clad 180 HR Ready-Mixed Aluminum, or equal.
 2. Fill nail recesses with putty or a glazing compound.
 3. Fill interior ceiling and wall cracks with spackling compound.
 4. Let fillers dry, then sand surfaces smooth.

5. Fill cracks or joints in or between wood, metal, masonry, glass, ceramic, plaster and plastics with a quality acrylic or siliconized acrylic latex caulk.
 6. Apply primer coat to back of wood trim and paneling.
- P. Doors:
1. Prior to finishing, apply additional primer or sealer coat to door tops and bottoms.
- Q. Field-Glazed Frames and Sash:
1. Prior to glazing, apply primer or sealer coat to glazing channels.
- R. Gypsum Plaster:
1. Cut out cracks, holes, indentations, and other surface defects to extent required for bonding adhesion; apply patching plaster or joint compound to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry; allow to cure 30 days before coating application.
- S. Portland Cement Plaster:
1. Cut out cracks, holes, indentations, and other surface defects to extent required for bonding adhesion; apply patching plaster to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry; allow to cure 30 days before coating application.
- T. Gypsum Board:
1. Repair cracks, holes, indentations, and other surface defects using joint compound to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry.
- U. Insulated Coverings, Canvas or Cotton:
1. Clean using high-pressure air and solvent of type recommended by coating manufacturer.
- V. Polyvinyl Chloride (PVC) Pipe:
1. Wipe clean and remove ink markings by wiping down with clean, lint-free cloths saturated with denatured alcohol.

3.04 APPLICATION

- A. Apply each coat to uniform coating thickness in accordance with manufacturer's instructions, not exceeding manufacturer's specified maximum spread rate for indicated surface; thins, brush marks, roller marks, orange-peel, or other application imperfections are not permitted.
- B. Allow manufacturer's specified drying time, and ensure correct coating adhesion, for each coat before applying next coat.
- C. Inspect each coat before applying next coat; touch-up surface imperfections with coating material, feathering, and sanding if required; touch-up areas to achieve flat, uniform surface without surface defects visible from 5 feet.
- D. Do not apply succeeding coat until Engineer has approved previous coat; only Engineer-approved coats will be considered in determining number of coats applied.
- E. Remove dust and other foreign materials from substrate immediately prior to applying each coat.
- F. Where coating application abuts other materials or other coating color, terminate coating with a clean sharp termination line without coating overlap.
- G. Where color changes occur between adjoining spaces, through framed openings that are of same color as adjoining surfaces, change color at outside stop corner nearest to face of closed door.

- H. Re-prepare and re-coat unsatisfactory finishes; refinish entire area to corners or other natural terminations.

3.05 MECHANICAL AND ELECTRICAL EQUIPMENT

- A. HVAC Louvers and Grilles:
 - 1. Finish in accordance with requirements for shop-primed ferrous metal items, including dampers visible behind units, color matching adjacent surfaces unless otherwise indicated.
- B. HVAC Ductwork:
 - 1. Finish interior surfaces visible through grilles and louvers with one coat acrylic flat wall paint; color black.
- C. Convectector and Baseboard Heating Cabinets:
 - 1. Finish in accordance with requirements for shop-primed ferrous metal items, including dampers visible behind units, color matching adjacent surfaces unless otherwise indicated; finish interior surfaces visible through grilles and louvers with one coat alkyd flat paint; color black.
- D. Piping, Ductwork, and Conduit Exposed to View in Finished Spaces:
 - 1. Finish in accordance with requirements for unprimed ferrous metal items, color matching adjacent surfaces unless otherwise indicated.
- E. Piping, Ductwork, and Conduit Exposed to View in Finished Utility, Mechanical, and Electrical Spaces:
 - 1. Finish in accordance with requirements for unprimed ferrous metal items.
 - 2. Provide identification markings.
 - 3. Use color matching adjacent surfaces, unless otherwise indicated.
 - 4. Do not allow coatings on identification tags or markings.
 - 5. Replace identification markings when painted accidentally.
- F. Access Panels, Electrical Panels, and Cover Plates:
 - 1. Finish in accordance with requirements for shop-primed ferrous metal items, including doors, door backs and sight-exposed cabinet surfaces, color matching adjacent surfaces unless otherwise indicated; do not allow coatings on identification plates, tags, or markings.

3.06 CURING OF COATINGS

- A. Contractor shall provide curing conditions in accordance with the conditions is the highest requirement, prior to placing the completed coating system into service.
 - 1. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.
- B. Forced Air Ventilation of Steel Reservoirs and Enclosed Hydraulic Structures:
 - 1. Forced air ventilation is required for the application and curing of coatings on the interior surfaces of steel reservoirs and enclosed hydraulic structures.
 - 2. During curing periods continuously exhaust air from a maintenance hole in the lowest shell ring, or in the case of an enclosed hydraulic structure, from the lowest level of the structure using portable ducting.
- C. After all interior coating operations have been completed provide a final curing period for a minimum of 10 days, during which the forced ventilation system shall operate continuously.

3.07 CLEANING

- A. Clean excess coating materials, and coating materials deposited on surfaces not indicated to receive coatings, as construction activities of this section progress; do not allow to dry.
- B. Re-install hardware, electrical equipment plates, mechanical grilles and louvers, lighting fixture trim, and other items that have been removed to protect from contact with coatings.
- C. Reconnect equipment adjacent to surfaces indicated to receive coatings.
- D. Relocate to original position equipment and fixtures that have been moved to allow application of coatings.
- E. Remove protective materials.

3.08 PROTECTION

- A. Protect completed coating applications from damage by subsequent construction activities.
- B. Repair to Engineer's acceptance coatings damaged by subsequent construction activities. Where repairs cannot be made to Engineer's acceptance, re-apply finish coating to nearest adjacent change of surface plane, in both horizontal and vertical directions.

3.09 SCHEDULE

- A. Metal Submerged (Non-potable Water):
 - 1. Coating: Coal Tar Epoxy with total dry film thickness of 18.5 mils.
 - 2. Surface Preparation: Near-White Blasting per SSPC-SP 10.
 - 3. Field Prime Coat: Polyamide Epoxy
 - a. Tnemec Series 66-1211 Hi-Epoxoline Primer
 - b. Carboline Bitumastic 300M
 - 4. First and Second Coats: Polyamide Epoxy - Coal Tar
 - a. Tnemec Series 46-413 Hi-Build Tneme-Tar
 - b. Carboline Bitumastic 300M
 - c. Sherwin-Williams Targuard Coal Tar Epoxy B69B60/B69V60
- B. Metal Submerged (Potable Water):
 - 1. Coating: NSF-approved high-solids epoxy system with total dry film thickness of 16.0 mils.
 - 2. Surface Preparation: Near-White Blasting per SSPC-SP 10
 - 3. Field Prime Coat: Polyamide Epoxy
 - a. Tnemec Series 20-1255 Pota-Pox
 - b. Carboline Carboguard 891
 - c. Sherwin-Williams Epoxide HS B62 Series
 - 4. First and Second Coat: Polyamidoamine Epoxy
 - a. Tnemec Series 140 Pota-Pox Plus
- C. Concrete Surfaces Submerged (Non-potable Water):
 - 1. Coating: Coal Tar Epoxy with total dry film thickness of 18.5 mils
 - 2. Surface Preparation: Near-White Blasting per SSPC-SP 10
 - 3. Field Prime Coat: Polyamide Coal Tar Epoxy
 - a. Tnemec Series 46-413 Teneme-Tar

- b. Carboline Bitumastic 300M
 - c. Sherwin-Williams Targuard Coal Tar Epoxy B69B60/B69V60
 - 4. First and Second Coats: Polyamide Coal Tar Epoxy
 - a. Tnemec Series 46-413 Hi-Build Tneme-Tar
 - b. Carboline Bitumastic 300M
 - c. Sherwin-Williams Targuard Coal Tar Epoxy B69B60/B69V60
- D. Concrete Surfaces Submerged (Potable Water):
 - 1. Coating: NSF-approved high-solids epoxy system with total dry film thickness 16.0 mils.
 - 2. Surface Preparation: Brush Off Blast per SSPC-SP 13
 - 3. Field Prime Coat: Polyamide Epoxy with odorless interior semi-gloss enamel (FS TT-E-509)
 - a. Tnemec Series 20-1255 Pota-Pox
 - b. Carboline Carboguard 891
 - c. Sherwin-Williams Epoxide HS B62 Series
 - 4. First and Second Coat: Polyamidoamine Epoxy
 - a. Tnemec Series 140 Pota-Pox Plus
- E. Concrete Surfaces, Interior:
 - 1. Surface Preparation: Clean and dry
 - 2. First and Second Coats: Interior acrylic latex, flat finish, two coats with total dry film thickness of 6.0 mils.
- F. Piping Systems, Steel, Ductile, or Cast Iron:
 - 1. Coating: Epoxy-polyamide with total dry film thickness of 6.0 mils
 - 2. Surface Preparation (if not shop primed): Near-White Blasting per SSPC-SP 10
 - 3. First and Second Coats: Polyamide Epoxy
 - a. Tnemec Series 66 Hi-Build Epoxoline
 - b. Carboline Carboguard 890
 - c. Sherwin-Williams Epolon Muti-Mil Epoxy
- G. Concrete Masonry Units (Interior):
 - 1. Coating: Interior polyamide epoxy in semi-gloss finish; three coats with total dry film thickness not less than 4.0 mils.
 - 2. Filler: Solvent-thinned block filler (FS-TT-F-1098). Apply filler coat at a rate to ensure complete coverage with pores filled.
 - 3. First Coat: Shellac pigmented primer (FS-TT-P-652) or undercoater as recommended by coating manufacturer.
 - a. _____
 - 4. Second and Third Coats: Polyamide Epoxy.
 - a. Tnemec Series 66 Hi-Build Epoxoline
 - b. Carboline Carboguard 890
 - c. Tru-Glaze 4508

- d. Sherwin-Williams Tie-Clad High Solids B62Z Series/B60VZ75
- H. Concrete Masonry Units (Exterior):
 - 1. Coating: Lusterless (Flat) acrylic finish; two coats over filler coat with total dry film thickness not less than 2.5 excluding filler coat.
 - 2. Filler Coat: High-performance latex block filler; heavy-duty latex block filler.
 - a. Tnemec Series 130
 - 3. First and Second Finish Coats: Acrylic Emulsion (FS TT-P-19)
 - a. Tnemec Series 6
 - b. Sherwin-Williams A-100 Exterior Flat Latex A6 Series
- I. Ferrous Metal (Interior - Mild Service):
 - 1. Coating: Semi-gloss enamel finish; two coats over primer, with total dry film thickness not less than 7.0 mils.
 - 2. Surface Preparation: Commercial Blast Cleaning per SSPC-SP 6
 - 3. Prime Coat: Rust Inhibitive primer. Prime coat is not required on items delivered shop primed.
 - a. Tnemec Series 10 Tnemec Primer
 - b. Carboline Carbocoat 150
 - c. Sherwin-Williams Kem Kromik Universal Primer B54 Series
 - 4. First Coat and Second Coat: Interior enamel undercoat (FS TT-E-543)
 - a. Tnemec Series 23 Enduratone
 - b. Carboline Carbocoat 139 and Carbocoat 30
 - c. Sherwin-Williams Industrial Enamel B54 Series
- J. Ferrous Metal (Interior - Severe Service):
 - 1. Coating: Epoxy-polyamide with total dry film thickness of 12.0 mils minimum
 - 2. Surface Preparation: Near-White Blasting SSPC-SP 10
 - 3. Prime Coat: Rust Inhibitive primer. Prime coat is not required on items delivered shop primed.
 - a. Tnemec Series 37H Tnemec Primer
 - b. Carboline Carbocoat 150
 - c. Sherwin-Williams Kem Kromik Universal Primer B54 Series
 - 4. First and Second Coats: Polyamide Epoxy
 - a. Tnemec Series 66 Hi-Build Epoxoline
 - b. Carboline Carboguard 890
 - c. Sherwin-Williams Epolon II Multi-Mil Epoxy
- K. Ferrous Metal (Exterior):
 - 1. coating: Semi-gloss enamel finish; two coats over primer, with total dry film thickness not less than 8.5 mils.
 - 2. Surface Preparation: Commercial Blast Cleaning SSPC-SP 6

3. Prime Coat: Rust Inhibitive primer. Prime coat is not required on items delivered shop primed.
 - a. Tnemec Series 10 Tnemec Primer
 - b. Sherwin-Williams Kem Kromik Universal Primer B54 Series
 4. First Coat and Second Coat: Interior enamel undercoat (FS TT-E-543)
 - a. Tnemec Series 23 Enduratone
 - b. Sherwin-Williams Industrial Enamel B54 Series
- L. Zinc Coated Metal (Interior):
1. Semi-Gloss Finish: Two coats over primer with total dry film thickness not less than 2.5 mils.
 2. Surface Preparation: Commercial Blast Cleaning SSPC-SP 6
 3. Prime Coat: Zinc Dust-Zinc Oxide Primer coating (FS TT-P-641)
 - a. Serwin-Williams Galvite HS Primer B50WZ30
 4. Second Coat: Interior Enamel Undercoat
 - a. Serwin-Williams ProMar 200 Alkyd Semi-Gloss Enamel B34 Series
 5. Third Coat: Odorless interior alkyd semi-gloss enamel
 - a. Serwin-Williams ProMar 200 Alkyd Semi-Gloss Enamel B34 Series
- M. Zinc Coated Metal (Exterior):
1. Coating: High gloss alkyd enamel; two finish coats over primer.
 2. Prime Coat: Zinc Dust-Zinc Oxide Primer coating (FS TT-P-641)
 - a. Serwin-Williams Galvite HS Primer B50WZ30
 3. First and Second Finish Coats: High Gloss Alkyd Enamel
 - a. Sherwin-Williams Industrial Enamel B54 Series
- N. Painted Wood and Hardboard (Interior - Living Space Exposure):
1. Coating: One or two finish coats over primer with a total dry film thickness of 4.5 mils, minimum.
 2. First Coat: Interior Enamel Undercoat
 - a. Tnemec Series 36 Undercoater
 - b. Sherwin-Williams PrepRite Wall & Wood Primer B49 Series
 3. Second and Third Coats: Odorless interior semi-gloss enamel (FS TT-E-509)
 - a. Tnemec Series 23 Enduratone
 - b. Serwin-Williams ProMar 200 Alkyd Semi-Gloss Enamel B34 Series
- O. Painted Wood and Hardboard (Interior - Chemical and Moisture Exposure):
1. Coating: One or two finish coats over primer with a total dry film thickness 8.0 mils, minimum
 2. First Coat: Alkyd primer/undercoater
 - a. Tnemec Series 36 Undercoater
 - b. Sherwin-Williams Kem Kromik Universal Primer B54 Series

3. Second and Third Coats: Waterborne acrylic epoxy in semi-gloss or satin
 - a. Tnemec Series 113 or 114 HB Tnemec Tufcoat
 - b. Sherwin-Williams Epo-Plex Multi-Mil
- P. Wood Trim (Exterior):
1. Coating: High Gloss Alkyd Enamel; two finish coats over primer. Not less than 7.5 mil dry film thickness.
 2. First Coat: Alkyd primer/undercoater:
 - a. Tnemec Series 36 Undercoater
 - b. Sherwin-Williams PrepRite Wall & Wood Primer B49 Series
 3. Second and Third Coats: Alkyd Enamel:
 - a. Tnemec Series 2H Tnemec-Gloss
 - b. Sherwin-Williams Industrial Enamel B54 Series
- Q. Stained Wood:
1. First Coat:
 - a. Semi-transparent oil stain
 - b. Sherwin-Williams Wood Classics Interior Oil Stain
 2. Second and Third Coats:
 - a. Polyurethane, lightly sanded between coats with steel wool.
 - b. Sherwin-Williams Wood Classics Polyurethane Varnish A67 Series Sherwin-Williams Wood Classics Polyurethane Varnish A67 Series.
- R. Gypsum Wallboard:
1. Coating: Two coats over primer/sealer with not less than 7.5 mils dry film thickness
 2. First Coat: Waterborne Vinyl Acrylic primer sealer
 - a. Tnemec Series 51-792 PVA Sealer
 3. Second and Third Coats: Odorless interior semi-gloss enamel, Alkyd enamel (TT-E-509)
 - a. Tnemec Series 23 Enduratone
 - b. Sherwin-Williams ProMar 200 Alkyd Semi-Gloss Enamel B34 Series

END OF SECTION

SECTION 22 05 13 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Three phase electric motors.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.
- C. NEMA MG 1 - Motors and Generators 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group

- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
1. Open drip-proof type except where specifically noted otherwise.
 2. Design for continuous operation in 104 degrees F environment.
 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 4. Motors with frame sizes 254T and larger: Energy efficient type.
- B. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Motors located in exterior locations and explosion proof environments: Totally enclosed type.
- B. Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.

2.04 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 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.
- I. Sound Power Levels: To NEMA MG 1.
- J. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

- K. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- L. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULES

- A. Three Phase - Energy Efficient, Totally Enclosed, Fan Cooled Performance:
 - 1. 1200 rpm.
 - a. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 63.
 - 3) Minimum Percent Efficiency: 86.
 - 2. 1800 rpm.
 - a. 3 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 83.
 - 3) Minimum Percent Efficiency: 87.
 - 3. 3600 rpm.
 - a. 3 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 87.
 - 3) Minimum Percent Efficiency: 82.

END OF SECTION

SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges.

1.02 REFERENCE STANDARDS

- A. AGA/ANSI B109 Set - INCLUDES ANSI B109.1, ANSI B109.2, ANSI B109.3, ANSI B109.4 2000.
- B. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements. for additional provisions.
 - 2. Extra Pressure Gauges: One of each type and size.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Ashcroft, Inc.
 - 2. Dwyer Instruments, Inc.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install pressure gauges as follows:
 - 1. At Pumps: Place single gauge before strainer, suction side and discharge side.
 - 2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
 - 3. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.

3.02 SCHEDULES

- A. Pressure Gauges, Location and Scale Range:
 - 1. Pumps, 0 to 100 psi.
 - 2. Pressure reducing valves, 0 to 100 psi.
 - 3. Backflow preventers, 0 to 100 psi.
- B. Pressure Gauge Tappings, Location:
 - 1. Control valves 3/4 inch & larger - inlets and outlets.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ball valves.
- B. Check valves.
- C. Gate valves.
- D. Chainwheels.

1.02 RELATED REQUIREMENTS

- A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- C. Section 22 10 05 - Plumbing Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

- A. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding 2022.
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- E. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- G. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.
- H. ASME B31.9 - Building Services Piping 2020.
- I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- J. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.
- K. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).

- L. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- M. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).
- N. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- O. AWWA C606 - Grooved and Shouldered Joints 2022.
- P. MSS SP-45 - Drain and Bypass Connections 2020.
- Q. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends 2011.
- R. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- S. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- T. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- U. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata.
- V. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided 2018.
- W. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- X. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.

5. Secure check valves in either the closed position or open position.
- B. Use the following precautions during storage:
 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

1.08 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

- A. Handle large valves with sling, modified to avoid damage to exposed parts.
- B. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- C. Provide the following valves for the applications if not indicated on drawings:
 1. Shutoff: Ball, butterfly, gate or plug.
 2. Swing Check (Pump Outlet):
 - a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. 2-1/2 inch and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.
 - c. 2-1/2 inch and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- E. Required Valve End Connections for Non-Wafer Types:
 1. Steel Pipe:
 - a. 2 inch and Smaller: Threaded ends.
 - b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - c. 5 inch and Larger: Grooved or flanged ends.
- F. Domestic, Hot and Cold Water Valves:
 1. 2 inch and Smaller:
 - a. Bronze and Brass: Provide with solder-joint ends.
 - b. Ball: One piece, full port, brass with brass trim.
 - c. Bronze Swing Check: Class 125, bronze disc.
 - d. Bronze Gate: Class 125, NRS.
 2. 2-1/2 inch and Larger:

- a. Iron, 2-1/2 inch to 4 inch: Provide with threaded ends.
 - b. Iron Ball: Class 150.
 - c. Iron Swing Check: Class 125, metal seats.
 - d. Iron Gate: Class 125, NRS.
- G. Sanitary Waste Water Valves:
 - 1. 2 inch and Smaller:
 - a. Bronze and Brass: Provide with solder-joint.
 - b. Ball: One piece, full port, brass with brass trim.
 - c. Bronze Swing Check: Class 125, bronze disc.
 - d. Bronze Gate: Class 125, NRS.
 - 2. 2-1/2 inch and Larger:
 - a. Iron, 2-1/2 inch to 4 inch: Provide with threaded ends.
 - b. Iron Ball: Class 150.
 - c. Iron Swing Check: Class 125, metal seats.
 - d. Iron Gate: Class 125, NRS.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 inch and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 inch and smaller except plug valves.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- E. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Solder-joint Connections: ASME B16.18.
 - 3. Building Services Piping Valves: ASME B31.9.
- F. Potable Water Use:
 - 1. Certified: Approved for use in compliance with NSF 61 and NSF 372.

2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.
- G. Valve Bypass and Drain Connections: MSS SP-45.
- H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 IRON, BALL VALVES

- A. Class 125, Full Port, Stainless Steel Trim:
 1. Comply with MSS SP-72.
 2. CWP Rating: 200 psi.
 3. Body: ASTM A536 Grade 65-45-12, ductile iron.
 4. End Connections: Flanged.
 5. Seats: PTFE.
 6. Operator: Lever with locking handle.

2.04 BRONZE, SWING CHECK VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125:
 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. WOG Rating: 200 psi.
 4. Body: Bronze, ASTM B62.
 5. End Connections: Threaded.
 6. Disc: Bronze.

2.05 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125 with Lever and Spring-Closure Control.
 1. Comply with MSS SP-71, Type I.
 2. Description:
 - a. CWP Rating: 200 psi.
 - b. Design: Clear or full waterway.
 - c. Body: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged as indicated.
 - e. Trim: Bronze.
 - f. Gasket: Asbestos free.
 - g. Closer Control: Factory installed, exterior lever, and weight.

2.06 BRONZE, GATE VALVES

- A. General:
 1. Fabricate from dezincification resistant material.

2. Copper alloys containing more than 15 percent zinc are not permitted.

2.07 IRON, GATE VALVES

- A. Bolted Bonnet: OS&Y; Rising Stem:
 1. Pressure and Temperature Rating: MSS SP-70, Type I.
 2. Class 125: WOG Rating; 200 psi.
 3. Body: ASTM A126, gray iron with bolted bonnet.
 4. End Connections: Flanged.
 5. Trim: Bronze.
 6. Disc: Solid wedge.
 7. Packing and Gasket: Asbestos free.

2.08 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to ball valve stems.
 3. Sprocket Rim with Chain Guides: Ductile iron. Include zinc coating.
 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve be determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Install check valves where necessary to maintain direction of flow as follows:
 1. Swing Check: Install horizontal maintaining hinge pin level.
- D. Provide chainwheels on operators for valves 4 inch and larger where located 96 inch or more above finished floor, terminating 60 inch above finished floor.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Strut systems for pipe or equipment support.
- B. Beam clamps.
- C. Pipe hangers.
- D. Pipe supports, guides, shields, and saddles.
- E. Anchors and fasteners.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 - Metal Fabrications.
- C. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- D. MFMA-4 - Metal Framing Standards Publication 2004.
- E. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, and post-installed concrete and masonry anchors.
 - 1. Fiberglass Strut Channel Framing Systems: Include requirements for strength derating according to ambient temperature.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- D. Derating Calculations for Fiberglass Strut Channel Framing Systems: Indicate load ratings adjusted for applicable service conditions.
- E. Installer's Qualifications: Include evidence of compliance with specified requirements.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- C. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.
- B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.
- C. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- D. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.
 - 1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
 - 2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.
- E. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.
 - 1. Outdoor, Damp, or Wet-Indoor Locations: Use stainless steel or approved equivalent unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Field-Welding (where approved by Engineer): Comply with Section 05 50 00.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Schedules:
 - 1. Submit plumbing component identification schedule listing equipment, piping, and valves.
 - 2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
 - 3. Valve Data Format: Include id-number, location, function, and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Nameplates:
 - 1. Control panels, transducers, and other related control equipment products.
 - 2. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.
- B. Tags:
 - 1. Piping: 3/4 inch diameter and smaller.
 - 2. Manual operated and automated control valves.
 - 3. Instrumentation, relays, gauges, and other related control equipment products.
- C. Stencil:
 - 1. Piping: 3/4 inch diameter and higher.
- D. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

- A. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch.

2.03 TAGS

- A. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.
- B. Piping: 3/4 inch diameter and smaller. Include corrosion resistant chain. Identify service, flow direction, and pressure.

2.04 STENCILS

- A. Pipe: Stencil size required per external insulated or uninsulated pipe diameter.
 - 1. 3/4 to 1-1/4 inch Range: 1/2 inch text over 8 inch long background.
 - 2. 1-1/2 to 2 inch Range: 3/4 inch text over 8 inch long background.
 - 3. 2-1/2 to 6 inch Range: 1-1/4 inch text over 12 inch long background.
 - 4. 8 to 10 inch Range: 2-1/2 inch text over 24 inch long background.
 - 5. Over 10 inches: 3-1/2 inch text over 32 inch long background.
- B. Equipment: Use 2-1/2 inch text using Owner defined scheme.
- C. Background Paint: Semi-gloss enamel in compliance with Section 09 91 23.
- D. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.
- E. Fluid Service Identification Scheme, ASME A13.1:
 - 1. Water; Potable, Cooling, Boiler Feed and Other: White text on green background.

2.05 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
- C. Flexible Tape Marker: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- D. Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
 - b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
 - c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
 - d. 8 to 10 inches: Use 24 inch field-length with 2-1/2 inch text height.
 - e. Over 10 inches: Use 32 inch field-length with 3-1/2 inch text height.
 - 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.
 - 3. Tertiary: Other Details.
 - a. Directional flow arrow.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 09 96 00.

3.02 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags in clear view and align with axis of piping.
- C. Apply stencil painted identification in compliance with Section 09 91 23 requirements. Identify unit with assigned id-number and area being served using pipe marking rules.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.
- F. Apply ASME A13.1 Pipe Marking Rules:
 - 1. Place pipe marker adjacent to changes in direction.
 - 2. Place pipe marker adjacent each valve port and flange end.
 - 3. Place pipe marker at both sides of floor and wall penetrations.
 - 4. Place pipe marker every 25 to 50 feet interval of straight run.

END OF SECTION

SECTION 22 10 00 PLUMBING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Section includes piping materials and installation methods including, but not limited to pipe, fitting and joining materials, piping specialties, and basic piping installation instructions.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures

1.03 REFERENCE STANDARDS

- A. ANSI B9.1, Standard Safety Code for Mechanical Refrigeration.
- B. ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.

1.04 SUBMITTALS

- A. Submit product data for the following:
 - 1. Escutcheons.
 - 2. Dielectric unions and fittings.
 - 3. Mechanical sleeve seals.
- B. Quality Control Submittals: Submit welders' certificates specified in Quality Assurance Article below.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Provide factory applied plastic end-caps on each length of pipe and tube except for concrete, corrugated metal, hub and spigot, and clay pipe.
- B. Maintain end-caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- C. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
- D. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.
- E. Store pipe in a manner to prevent sagging and bending.

1.06 QUALITY ASSURANCE

- A. Welder's Qualifications: Welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- B. Welding procedures and testing shall comply with ANSI B31.1.0 and ANSI B9.1.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pipe Escutcheons:
 - a. Chicago Specialty Mfg. Co.
 - b. Grinnell.

- c. Sanitary-Dash Mfg. Co.
- 2. Dielectric Waterway Fittings:
 - a. Epco Sales, Inc.
 - b. Victaulic Company of America.
- 3. Dielectric Unions:
 - a. Eclipse, Inc.
 - b. Perfection Corp.
 - c. Watts Regulator Co.
- 4. Mechanical Sleeve Seals:
 - a. Thunderline Corp.
- 5. High-Impact Thermoplastic Wall Sleeve:
 - a. Thunderline.
 - b. Silicone Rubber Adhesive:
 - c. General Electric.
- 6. High-Density Polyethylene Pipe (64.2):
 - a. Driscopipe 8000.
 - b. Nipak.
 - c. Dupont.
- 7. High-Density Polyethylene Pipe (64.7):
 - a. Driscopipe 8600.
 - b. Nipak.
 - c. Dupont.

2.02 MATERIALS

- A. Refer to the individual piping system specifications in Sections 22 1113 for specifications on piping materials required from those listed below:

- 1. Steel Pipe (61.1):
 - a. Normal Service Pressure: Up to 150 psig
 - b. Temperature: Up to 366 degrees Fahrenheit

Type	Size	Specification
Pipe	1/4-inch thru 4-inch	Carbon steel pipe, Schedule 40, ASTM A 120 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
Types of Joints	1/4-inch thru 2-inches	Screwed
	2-1/2-inch and larger	Welded
Fittings	1/4-inch thru 2-inches	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3
Nipples	1/4-inch thru 2-inches	Carbon steel, extra strong, ASTM A 120 or A 53

Unions	1/4-inch thru 2-inches	Malleable iron, 250-pound class (500 WOG), railroad type with brass seats
Thread Sealant		Pipe dope. John Crane Insoluble Plastic Lead seal No. 2 or approved equal. Exception: For temperatures in excess of 250 degree Fahrenheit, use Teflon ribbon, 1/2-inch wide.

2. Cast Iron (62.2):

- a. Temperature: Up to 180 degrees Fahrenheit

Type	Size	Specifications
Pipe	2-inches thru 15-inches	Cast iron soil pipe, plain end, service weight (SV), bituminous coating inside and outside. Cast Iron Soil Pipe Institute Std. 301
Type of Joints	2-inches thru 15-inches	No-hub coupling.
Fittings	2-inches thru 15-inches	Cast iron soil pipe, no-hub type, service weight (SV), bituminous coating inside and outside. Cast Iron Soil Pipe Institute Std. 301.

3. Copper Tubing (63.1):

- a. Normal Service Pressure: Up to 150 psig
b. Temperature: Up to 250 degrees Fahrenheit
c. Use solder fittings at all joints between terminal points.
d. Bends may be used for 1/4-inch and 3/8-inch tubing.
1) Bends shall be made with a bending tool to the following minimum radii:
(a) 1/4-inch: 9/16-inch minimum radius
(b) 3/8-inch: 15/16-inch minimum radius

Type	Size	Specification
Pipe	All sizes	Copper tubing, type L, hard-drawn above ground. Type K (soft) for below grade
Types of Joints	1/4-inch thru 1/2-inch	Soldered or compression type as required
	5/8-inch and larger	Soldered (Exposed), Flared (Buried)
Compression	1/4-inch thru 1/2-inch	Brass compression type fittings
Fittings (Exposed)	All sizes	Gyrolok, Swagelok, Parker CPI
Unions	1/4-inch thru 2-inches	Wrought copper or cast bronze; solder joint union
Flanges	All sizes	Copper, solder-joint flange. 150-pound ASME drilling. Raised or flat face to match equipment
Gaskets		1/16-inch Teflon; ring type for raised-face, or full-face for flat face flange
Solder		Tin/Antimony (or lead-free to meet Code requirements)
Thread Sealant		Teflon tape

4. High Density Polyethylene Pipe (64.2) for Gas Distribution:

- a. Normal Service Pressure: 80 psig

- b. Temperature: Up to 140 degrees Fahrenheit

Type	Size	Specifications
Pipe	3/4-inch and larger	High-density polyethylene, SDR-11, ASTM D2513, PE 3408
Type of Joints	3/4-inch and larger	Fusion welded, ASTM D2513 or socket
Fittings	3/4-inch and larger	High-density polyethylene, SDR-11, socket fusion type, with diameters compatible with pipe for fusion joining
Gaskets	3/4-inch and larger	1/16-inch solid neoprene, full-face type
Flanges	3/4-inch and larger	PVC, 150-pound, flat-face, Sch 80, socket type

5. PVC DWV Pipe (64.6):

- a. Normal Service Pressure: 5 psig (maximum)
b. Temperature: Up to 150 degrees Fahrenheit

Type	Size	Specifications
Pipe	1-inch thru 8-inches	PVC, Sch 40, ASTM D2665
Type of Joints	1-inch thru 8-inches	Solvent welded
Fittings	1-inch thru 8-inches	PVC, Sch 40, socket type, ASTM D2949

6. High-Density Polyethylene Pipe (64.7) for Sump Discharge:

- a. Normal Service Pressure: 80 psig (maximum)
b. Temperature: Up to 140 degrees Fahrenheit

Type	Size	Specifications
Pipe	3/4-inch and larger	High-density polyethylene, SDR-11, ASTM D3350, PE 3408
Type of Joints	3/4-inch and larger	Fusion welded, ASTM D 3261 or socket. ASTM D2683
Fittings	3/4-inch and larger	High-density polyethylene, SDR-11, socket fusion type, with diameters compatible with pipe for fusion joining
Gasket	3/4-inch and larger	1/16-inch solid hypalon, full-face type
Flanges	3/4-inch and larger	PVC, 150-pound, flat-face, Sch 80, socket type

2.03 JOINTING MATERIALS

- A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- C. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed, and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPING SPECIALTIES

- A. Escutcheons: Chrome plated, stamped steel, hinged, split-ring escutcheon with setscrew. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions: Malleable iron, Class 150 for low-pressure service and Class 250 for high-pressure service; hexagonal stock with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Insulated and gasketed, galvanized, malleable iron unions as manufactured by Crane No. 1259, ITT-Grinnell, Figure 470, or equal.
- D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
- E. Sleeves: Unless otherwise shown on Drawings, at all points where pipes must pass through walls, floors or roofs of structures, Contractor shall furnish and install suitable sleeves or wall castings.
 - 1. In general, the wall sleeve or casting shall be of the same material as the pipe, or standard weight steel pipe thimbles of at least 1 size larger than the pipe itself shall be installed. Iron pipe wall castings, wall pipe, transition sleeves and solid sleeves shall meet the requirements or 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. Sleeves shall be shop coated with universal primer 2 mils minimum thickness.
 - 2. A high-impact thermoplastic wall sleeve as manufactured by Thunderline may be used for low and standard temperature service.
- F. Sleeve Seals:
 - 1. Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be caulked at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of the other walls, and at the top surface of floors and slabs. The space shall be caulked with lead and oakum as specified under Bell and Spigot Lead with an RTV-silicone rubber adhesive as manufactured by General Electric or sealed with a rubber link seal. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers.
 - 2. Sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, and chemical action.
 - 3. 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.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION

- A. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as

practical, install piping as indicated. Refer to individual system specifications for requirements for submittals.

- B. Piping shall be exposed unless indicated otherwise.
- C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on Drawings.
- E. Install piping far enough from slabs, beams, joists, columns, walls, and other permanent elements of the building to permit access for painting. Provide space to permit insulation applications, with 3-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.

3.03 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2-inch and smaller connections, and elsewhere as indicated.
- D. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).
- E. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

3.04 JOINTS

- A. Steel Pipe Joints:
 - 1. Pipe 2-inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1.
 - a. Cut threads full and clean using sharp dies.
 - b. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- B. Pipe Larger than 2-inches:
 - 1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0, Standard Code for Pressure Piping, Power Piping, and ANSI B9.1, Standard Safety Code for Mechanical Refrigeration.
 - 2. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4-inch and smaller.
 - 3. Joints for other piping materials are specified within the respective piping system sections.

3.05 TESTING

- A. Refer to individual piping system specification Sections for more information regarding testing.

END OF SECTION

SECTION 22 10 05
PLUMBING PIPING
END OF SECTION

SECTION 22 14 29 SUMP PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Section includes submersible sump pump and related appurtenances.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 77 00 - Closeout Procedures

1.03 REFERENCE STANDARDS

- A. Hydraulic Institute Compliance: Design, manufacture, and install pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Components shall comply with NFPA 70 - National Electrical Code.
- C. UL Compliance: Pumps shall be listed and labeled by UL and comply with UL 778 - Motor Operated Water Pumps.
- D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.
- E. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with the Sump and Sewage Pump Manufacturers Association (SSPMA) Standards.

1.04 SUBMITTALS

- A. Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings showing layout and connections for pumps. Include setting Drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
 - 2. Product data including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
 - 3. Contractor shall submit to Engineer for approval performance curves on each pump. These curves shall include capacity, head, required NPSH efficiency and horsepower required for operation as shown on Pump Schedule and on Drawings.
 - 4. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 77 00 - Closeout Procedures, operation and maintenance manuals for items included under this Section.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Apply factory finish paint to assembled, tested units prior to shipping.
- B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anti-corrosion compound. Protect flanges, pipe openings, and nozzles.
 - 1. Store pumps in a dry location.
 - 2. Retain shipping flange protective covers and protective coatings during storage.

3. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
 4. For extended storage times (greater than 30 days), dry internal parts with hot air or a vacuum-producing device. After drying, coat internal parts with light oil, kerosene, or antifreeze. Dismantle bearings and couplings, dry and coat with an acid-free, heavy oil, and tag and store in dry location.
- C. Comply with manufacturer's rigging instructions for handling, if required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Pump shall be a submersible model as manufactured by:
1. ABS Model EJ 04W-2
 2. Engineer approved equal

2.02 EQUIPMENT

- A. Pump shall be a heavy-duty submersible model.
- B. Casing: Cast iron.
- C. Impeller: PTB Vortex impeller capable of passing 2-inch solids.
- D. Seal: Ceramic-faced mechanical seal.
- E. Shaft: Shaft shall be stainless steel.
- F. Motor: Motors shall be hermetically sealed.
- G. Controls: Fully automatic, equipped with a piggyback float switch.
- H. Pump Discharge Piping: 2-inch discharge. Contractor shall provide discharge check and gate valve meeting the appropriate specifications.
- I. Basin: Provide a 30-inch diameter by 36-inch deep fiberglass basin with a 30-inch aluminum cover bolted to the basin top, unless specified otherwise in the Contract Drawings. Cover shall include manhole, vent, discharge connections, and openings for power connection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The following requirements apply only to pumps furnished under this Section. Pumps furnished under other Sections may have different requirements.
1. Examine areas, equipment foundations, and conditions for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.
 2. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

3.02 INSTALLATION

- A. Comply with manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- D. Electrical wiring and connections are specified in Division 26.

END OF SECTION

SECTION 22 40 00 PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Service sinks.

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealing joints between fixtures and walls and floors.
- B. Section 22 10 05 - Plumbing Piping.
- C. Section 22 10 06 - Plumbing Piping Specialties.
- D. Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- C. ASME A112.19.3 - Stainless Steel Plumbing Fixtures 2022.
- D. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- E. ITS (DIR) - Directory of Listed Products Current Edition.
- F. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
- G. NSF 372 - Drinking Water System Components - Lead Content 2022.
- H. UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on-site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Maximum Fixture or Faucet Supply Pressure: 60 psi unless stated otherwise.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for installation of plumbing systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 SERVICE SINKS

- A. Manufacturers:
 - 1. Elkay Manufacturing Company
 - 2. Zurn Industries, LLC
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Self-Standing, Double-Bowl, Laundry Sink: Four-hole, white finished, plastic-composite bowl, 30-gal capacity with fitted drain and stopper. Size as indicated on drawings.
- C. Trim: ASME A112.18.1 exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
- D. Two-Lever Handle Service Faucet:
 - 1. Type: Wall-mount spout faucet with union inlets and mounting plate.
 - 2. Spray Type: Full stream spray at 1.8 gpm, maximum.
 - 3. ASME A112.18.1, ADA Standards, and NSF 61 compliant assembly.
 - 4. Materials: Ceramic disc cartridge valve on brass body with polished chrome finish.

2.04 HOSE BIB BOXES

- A. Material: 316 stainless steel.
- B. Finish: Satin.
- C. Mount in wall fully recessed.
- D. Provide with NPT PVC ball valves and fittings.
- E. Provide with internal hose drain bracket and waste outlet.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.02 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Install components level and plumb.
- C. Install and secure fixtures in place with wall supports and bolts.

3.04 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.05 CLEANING

- A. Clean plumbing fixtures and equipment.
- B. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

3.06 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

3.07 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
- B. Fixture Rough-In
 - 1. Service Sink:
 - a. Cold Water: 1/2 Inch.
 - b. Waste: 3 Inch.
 - c. Vent: 1-1/2 Inch.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. General construction and requirements.
- B. Applications.
- C. Three phase electric motors.

1.02 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.
- C. NEMA MG 1 - Motors and Generators 2018.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

- A. See Section 01 77 00 - Closeout Procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors Larger than 1/2 Horsepower: 480 volts, three phase, 60 Hz.
- B. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- E. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.
- B. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

2.04 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 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.
- H. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

- I. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- J. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULE

- A. Three Phase - Energy Efficient, Totally Enclosed, Fan Cooled Performance:

- 1. 1200 rpm.
 - a. 1 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 72.
 - 3) Minimum Percent Efficiency: 81.
 - b. 1-1/2 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 83.
 - c. 2 hp:
 - 1) NEMA Frame: 184T.
 - 2) Minimum Percent Power Factor: 68.
 - 3) Minimum Percent Efficiency: 85.
 - d. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 63.
 - 3) Minimum Percent Efficiency: 86.
- 2. 1800 rpm.
 - a. 1 hp:
 - 1) NEMA Frame: 143T.
 - 2) Minimum Percent Power Factor: 84.
 - 3) Minimum Percent Efficiency: 82.
 - b. 1-1/2 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 85.
 - 3) Minimum Percent Efficiency: 84.

- c. 2 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 85.
 - 3) Minimum Percent Efficiency: 84.
- d. 3 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 83.
 - 3) Minimum Percent Efficiency: 87.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Vibration isolation requirements.
- B. Vibration-isolated equipment support bases.
- C. Vibration isolators.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 05 50 00 - Metal Fabrications

1.03 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASCE 19 - Structural Applications of Steel Cables for Buildings 2016.
- C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. MFMA-4 - Metal Framing Standards Publication 2004.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.06 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for submittal procedures.
- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.

- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 - 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
- E. Shop Drawings - Seismic Controls:
 - 1. Include dimensioned plan views and sections indicating proposed HVAC component locations and distributed system routing, with locations and details of gravity supports and seismic restraints and associated attachments.
 - 2. Identify anchor manufacturer, type, minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 - 3. Indicate proposed arrangement of distributed system trapeze support groupings.
 - 4. Indicate proposed locations for distributed system flexible fittings and/or connections.
 - 5. Indicate locations of seismic separations where applicable.
 - 6. Include point load drawings indicating design loads transmitted to structure at each attachment location.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Evidence of qualifications for manufacturer.
- H. Manufacturer's detailed field testing and inspection procedures.
- I. Field quality control test reports.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.

2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 3. Select vibration isolators for outdoor equipment to comply with wind design requirements.
 4. Select vibration-isolated equipment support bases and associated vibration isolators to provide minimum 2-inch operating clearance beneath base unless otherwise indicated.
- D. Equipment Isolation:
1. Equipment Type: Fan.
 - a. Isolator Type (Non-seismic Application): Restrained spring isolators.
- E. Thrust Restraint Applications:
1. Use thrust restraints to resist horizontal motion due to thrust for fan heads, suspended fans, and base-mounted and suspended air handling equipment operating at 2.0 inches wg or greater total static pressure.
 2. Minimum Static Deflection: Same as static deflection of equipment.
 3. Limit lateral movement to 0.25 inch or less unless otherwise indicated.

2.02 VIBRATION ISOLATORS

- A. Manufacturers:
1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries
 - c. Vibration Eliminator Company, Inc.
 - d. Vibro-Acoustics
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. General Requirements:
1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
- C. Vibration Isolators for Non-seismic Applications:
1. Resilient Material Isolator Pads:
 - a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material.

- b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.
 - c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
- 2. Resilient Material Isolator Mounts, Non-seismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material; fail-safe type.
- 3. Open (Unhoused) Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.
 - b. Bottom Load Plate: Nonskid, molded, elastomeric isolator material or steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
- 4. Housed Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
- 5. Restrained Spring Isolators, Non-seismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
 - b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
- 6. Resilient Material Isolator Hangers, Non-seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.
- 7. Spring Isolator Hangers, Non-seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.

- b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
- 8. Combination Resilient Material/Spring Isolator Hangers, Non-seismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
- 9. Thrust Restraints:
 - a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g., air pressure from a fan), and intended for installation in pairs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 CODE-REQUIRED SPECIAL INSPECTIONS

- A. Arrange work to accommodate tests and/or inspections performed by Special Inspection Agency employed by Owner or Engineer in accordance with Section 01 45 33 and statement of special inspections as required by applicable building code.
- B. Frequency of Special Inspections: Where special inspections are designated as continuous or periodic, arrange work accordingly.
 - 1. Continuous Special Inspections: Special Inspection Agency to be present in the area where the work is being performed and observe the work at all times the work is in progress.
 - 2. Periodic Special Inspections: Special Inspection Agency to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.
- C. Prior to starting work, Contractor to submit written statement of responsibility to authorities having jurisdiction and to Owner acknowledging awareness of special requirements contained in the statement of special inspections.
- D. Special Inspection Agency services do not relieve Contractor from performing inspections and testing specified elsewhere.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:

1. Spring Isolators:
 - a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
2. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
3. Thrust Restraints:
 - a. Adjust restraint movement under normal operating static pressure.
4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
6. Adjust isolators to be free of isolation short circuits during normal operation.
7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 45 00 - Quality Control, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.
- D. Vibration Isolation Systems:
 1. Verify isolator static deflections.
 2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Testing, adjustment, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.
- C. Vibration measurement of equipment operating conditions.
- D. Commissioning activities.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 08 00 - Commissioning of HVAC.

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Engineer.
 - 2. Submit to the Commissioning Authority.
 - 3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 4. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Engineer and other installers to sufficiently understand the design intent for each system.
 - 5. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:

- 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
- h. Expected problems and solutions, etc.
 - i. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - k. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - l. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - m. Method of checking building static and exhaust fan and/or relief damper capacity.
 - n. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - o. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - p. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Commissioning Authority.
- E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.

- f. Project Engineer.
- g. Project Contractor.
- h. Project altitude.
- i. Report date.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- E. TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature 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. Access doors are closed and duct end caps are in place.
 - 8. Air outlets are installed and connected.

- 9. Duct system leakage is minimized.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

3.04 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure 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 or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Measure air quantities at air inlets and outlets.
- C. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- D. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- E. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.06 COMMISSIONING

- A. Perform prerequisites prior to starting commissioning activities.
- B. Fill out Prefunctional Checklists for:
 - 1. Water side systems.
- C. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- D. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.

2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3.07 SCOPE

- A. Test, adjust, and balance the following:

1. Fans.

3.08 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:

1. Manufacturer.
2. HP/BHP.
3. Phase, voltage, amperage; nameplate, actual, no load.
4. RPM.
5. Service factor.
6. Starter size, rating, heater elements.
7. Sheave Make/Size/Bore.

- B. Exhaust Fans:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

- C. Duct Leak Tests:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test static pressure.
7. Test orifice differential pressure.
8. Leakage.

D. Vibration Tests:

1. Location of points:
 - a. Fan bearing, drive end.
 - b. Fan bearing, opposite end.
 - c. Motor bearing, center (if applicable).
 - d. Motor bearing, drive end.
 - e. Motor bearing, opposite end.
 - f. Casing (bottom or top).
 - g. Casing (side).
 - h. Duct after flexible connection (discharge).
 - i. Duct after flexible connection (suction).
2. Test readings:
 - a. Horizontal, velocity and displacement.
 - b. Vertical, velocity and displacement.
 - c. Axial, velocity and displacement.
3. Normally acceptable readings, velocity and acceleration.
4. Unusual conditions at time of test.
5. Vibration source (if non-complying).

END OF SECTION

SECTION 23 08 00 COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- B. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- C. Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - HVAC&R Technical Requirements for the Commissioning Process 2007, with Errata (2012).

1.03 SUBMITTALS

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.

5. Full print out of all schedules and set points after testing and acceptance of the system.
 6. Full as-built print out of software program.
 7. Electronic copy on disk of the entire program for this facility.
 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 10. Control equipment component submittals, parts lists, etc.
 11. Warranty requirements.
 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- D. Project Record Documents:
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- E. Draft Training Plan:
1. Follow the recommendations of ASHRAE Guideline 1.1.
 2. Control system manufacturer's recommended training.
 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals:
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
 - 5. Command valve/damper to a few intermediate positions.
 - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.

- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
 - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
 - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
 - 1. Setpoint changing features and functions.
 - 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
 - 1. That all specified functions and features are set up, debugged and fully operable.
 - 2. That scheduling features are fully functional and setup, including holidays.
 - 3. That all graphic screens and value readouts are completed.
 - 4. Correct date and time setting in central computer.

5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
 7. Power failure and battery backup and power-up restart functions.
 8. Global commands features.
 9. Security and access codes.
 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 11. O&M schedules and alarms.
 12. Occupancy sensors and controls.
 13. All control strategies and sequences not tested during controlled equipment testing.
- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. Add design intent documentation furnished by Engineer to manuals prior to submission to Owner.
- B. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- C. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

- A. See Section 01 79 00 for additional requirements.
- B. Demonstrate operation and maintenance of HVAC system to Owner's personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Owner's personnel for minimum 4 hours, after completion of TAB, on the following:
 1. Review final TAB report, explaining the layout and meanings of each data type.
 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.

4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
1. Phase 1 - Basic Control System: Provide minimum of 4 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 4 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
 - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
 - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
 - d. Every display screen, allowing time for questions.
 - e. Point database entry and modifications.
 3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 4 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 31 00 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Metal ducts.
- B. Flexible ducts.
- C. Nonmetal ducts.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC
- B. Section 23 33 00 - Air Duct Accessories

1.03 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ASHRAE Std 126 - Method of Testing HVAC Air Ducts 2020.
- D. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- E. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip 2023.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.
- G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2023.
- H. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- I. ICC (IMC) - International Mechanical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2018, with Editorial Revision (2020).
- K. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry 2018, with Editorial Revision (2020).
- L. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2017, with Editorial Revision (2020).
- M. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements 2023.
- N. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- O. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- P. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids 2020.
- Q. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

- R. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.
- S. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards 2007.
- T. SMACNA (ROUND) - Round Industrial Duct Construction Standards 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
- D. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meets or exceeds specified requirements.
- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- F. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- G. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.07 WARRANTY

- A. See Section 01 77 00 - Closeout Procedures for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated. Fibrous glass duct can be substituted at the Contractor's option.
- C. Duct Shape and Material in accordance with Allowed Static Pressure Range:
 - 1. Round: Plus or minus 2 in-wc of stainless steel.
 - 2. Rectangular: Plus or minus 2 in-wc of stainless steel.
 - 3. Flexible Duct (Fabric and wire): Plus or minus 1/2 in-wc
- D. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Supply Air: 1 in-wc pressure class, stainless steel.
 - b. Outside Air Intake: 1 in-wc pressure class, stainless steel.

- c. General Exhaust Air: 1 in-wc pressure class, stainless steel.
- 2. Low Pressure Service: Up to 2 in-wc:
 - a. Seal: Class C, apply to seal off transverse joints.
 - b. Leakage:
 - 1) Rectangular: Class 24 or 24 cfm/100 sq ft.
 - 2) Round: Class 12 or 12 cfm/100 sq ft.
- 3. Low Pressure Service: From 2 in-wc to 3 in-wc:
 - a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
 - b. Leakage:
 - 1) Rectangular: Class 12 or 12 cfm/100 sq ft.
 - 2) Round: Class 6 or 6 cfm/100 sq ft.
- 4. Medium and High Pressure Service: Above 3 in-wc:
 - a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
 - b. Leakage:
 - 1) Rectangular: Class 6 or 6 cfm/100 sq ft.
 - 2) Round: Class 3 or 3 cfm/100 sq ft.
- E. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
 - 4. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 5. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

- A. Material Requirements:
 - 1. Stainless Steel: ASTM A666, Type 304.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products following the manufacturer's instructions.
- C. Comply with safety standards NFPA 90A and NFPA 90B.

- D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use double nuts and lock washers on threaded rod supports.
- I. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- J. Painting: Provide surface finish as indicated on Drawings. 23.

3.02 CLEANING

- A. Clean thoroughly each duct system.
- B. Clean duct system by forcing air at high velocity through duct to remove accumulated dust. Clean half the system at a time to obtain sufficient air. Protect equipment that could be harmed by excessive dirt with temporary filters or bypass during cleaning.

END OF SECTION

SECTION 23 33 00 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Backdraft dampers - metal.
- B. Backdraft dampers - fabric.
- C. Duct test holes.
- D. Flexible duct connectors.
- E. Low leakage (Class 1A) control dampers.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- B. Section 23 31 00 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

1.04 SUBMITTALS

- A. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- C. Project Record Drawings: Record actual locations of test holes.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
 - 1. Ruskin Company
 - 2. Approved equal
- B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.02 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated.
 - 1. Blades: Neoprene coated fabric material.
 - 2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 - 3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.03 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
 - 1. Manufacturers:
 - a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal
 - b. Approved equal

2.04 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd.
 - 2. Metal: 3 inches wide, 24 gauge, 0.0239 inch thick stainless steel.

2.05 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company; CD50: www.ruskin.com/#sle.
 - 2. Approved equal..
- B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.
- C. Frame:
 - 1. Material: 20-gauge 316 stainless steel.
 - 2. Free-area: Single cross section.
- D. Blade:
 - 1. Type: Single-blade rectangle shape.
 - 2. Operation: Opposed type.
 - 3. Maximum Individual Blade Height: 8 inches.
 - 4. Material: 12-gauge 316 stainless steel.
 - 5. Authority: Opposed type, 5 to 50 percent (typically 10 percent).
- E. Temperature Service Range: Minus 25 to 185 degrees F.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS).
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- E. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

END OF SECTION

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Backward inclined centrifugal fans.
- B. Forward curved centrifugal fans.
- C. Radial centrifugal fans.
- D. Bearings and drives.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- C. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014 (Reaffirmed 2020).
- C. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
- D. AMCA 99 - Standards Handbook 2016.
- E. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.
- H. NEMA MG 1 - Motors and Generators 2018.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

1.04 SUBMITTALS

- A. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Include complete installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each individual fan.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.07 FIELD CONDITIONS

- A. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ACME Engineering and Manufacturing Corporation
- B. Loren Cook Company
- C. Greenheck Fan Corporation
- D. Approved equal

2.02 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Comply with AMCA 99.
- D. Performance Base: Sea level conditions.

2.03 WHEEL AND INLET

- A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.
- B. Forward Curved: Black enameled steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to backplate and keyed to shaft with set screw.
- C. Radial: Steel construction with inlet flange, heavy reinforced back plate, plate blades with reinforcing gussets welded or riveted to back plate and flange; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

2.04 BEARINGS AND DRIVES

- A. Bearings: Heavy duty pillow block type, self-greasing ball bearings, with ABMA STD 9 life at 50,000 hours.
- B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
- C. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
- D. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.05 ACCESSORIES

- A. Discharge Dampers: Parallel blade heavy-duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
- B. Access Doors: Shaped to fit scroll, with quick opening latches and gaskets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install fans with resilient mountings and flexible electrical leads, see Sections 23 05 48 - Vibration and Seismic Controls for HVAC.
- C. Install flexible connections between fan inlet and discharge ductwork; see Section 23 33 00 - Air Duct Accessories. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- D. Install fan restraining snubbers; see Sections 23 05 48 - Vibration and Seismic Controls for HVAC. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

END OF SECTION

SECTION 23 82 00

CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Electric unit heaters.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- F. UL 674 - Electrical Motors and Generators for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data: Provide typical catalog of information including arrangements.
- B. Shop Drawings:
 - 1. Submit the following for valance heating and cooling units indicating:
 - a. Scaled layouts showing valance type, capacity, coil and panel lengths.
 - b. Installation and construction details for all valance types.
 - c. Location drawings for mounting heights.
 - 2. Indicate mechanical and electrical service locations and requirements.
- C. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- D. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 ELECTRIC UNIT HEATERS

- A. Manufacturers:
 - 1. Modine Manufacturing Company
 - 2. Trane Technologies, PLC
 - 3. Approved equal
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- C. Heating Element Assembly:
 - 1. Thermal safety cut-out within electric terminal box with automatically reset switch located near electric terminal box.
 - 2. Horizontal Projection Units:
 - a. Steel fins copper brazed to steel sheath and epoxy sealed for moisture resistance.
 - b. Nickel chromium resistance wire surrounded with magnesium oxide and sheathed in steel, spiral-finned tubes.
- D. Housing:
 - 1. Suitable for ceiling or high-altitude mount using provided hardware appendages.
 - 2. Horizontal Projection Units:
 - a. Construction materials to consist of heavy gauge steel with galvanized, polyester powder coat, or high gloss baked enamel finish.
 - b. Provide with threaded holes for threaded rod suspension.
 - c. Provisions for access to internal components for maintenance, adjustments, and repair.
 - d. Watertight construction for high moisture, corrosive prone washdown spaces.
- E. Air Inlets and Outlets:
 - 1. Inlets: Provide stamped louvers or protective grilles with fan blade guard.
 - 2. Outlets: Provide diffuser cones, directional louvers, or radial diffusers.
- F. Fan: Factory balanced, direct drive, axial type with fan guard.
- G. Motor: Totally enclosed, thermally protected, and provided with permanently lubricated bearings.
- H. Controls:
 - 1. Fan override to purge residual heat when de-energized.
 - 2. Built-in line-voltage thermostat.
- I. Electrical Characteristics:
 - 1. Disconnect Switch: Factory mount disconnect switch.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.

- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Do not damage equipment or finishes.
- D. Unit Heaters:
 - 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
 - 2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

3.03 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

END OF SECTION

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish labor, material, and equipment required for the installation of the electrical systems, modifications to existing electrical systems, and the completion of the work as herein specified and/or indicated on the Drawings. It is the intent that the Drawings and Specifications, which are general only, shall provide for finished, first-class work, and that the equipment and appurtenances thereto shall be of such construction and details, and of such materials, as to function completely and properly, and so as to be of long life; and such as not to require excessive upkeep or maintenance; and that operation shall be simple and control convenient. Any items omitted therefrom which are clearly necessary for the completion of the work or its appurtenances shall be considered a portion of the work though not directly specified or shown. Work shall conform with NECA 1, Standards Good Workmanship in Electrical Construction.
- B. Contractor shall install and wire remote mounted heating and ventilating thermostats, electrical components, and control panels furnished by the equipment suppliers in accordance with other Sections of these Specifications.
- C. Contractor shall install and wire electric resistance heaters and any associated, remote mounted thermostats furnished under other Sections of these Specifications.
- D. Contractor shall provide and install conduit and wire connections required between components of equipment and systems supplied under other Sections of these Specifications, where shown or indicated on the Contract Drawings.
- E. Contractor shall furnish and install complete secondary power distribution systems and modifications to existing secondary power distribution systems.
- F. Contractor shall furnish and install a complete lighting system.
- G. Contractor shall furnish and install complete auxiliary systems and existing auxiliary system modifications, as specified herein and as shown on the Contract Drawings.

1.02 DESCRIPTION OF SYSTEMS

- A. Existing secondary power shall be 480 volts, 3 phase, 3 wire plus ground, 60 Hertz supplied from the existing MCC.
- B. Lighting system shall be 120/240 volts, 3 phase, 4 wire plus ground, 60 Hertz supplied from the existing lighting panel.

PART 2 PRODUCTS

2.01 GENERAL

- A. Contractor shall furnish and install modifications to the existing power distribution system, together with necessary supports, framing, hangers, and other appurtenances. Contractor shall furnish and arrange for the setting of anchor bolts, channels, etc. which are to be set in the concrete. Contractor shall connect and make operable electrical equipment whether or not it was furnished under other Sections of these Specifications. Work shall include, but is not limited to, the following items:
 - 1. Electrical Equipment and Devices
 - 2. Raceway System
 - 3. Power Feeder and Branch Circuit Wiring
 - 4. Modifications to Existing Motor Control Centers

5. Disconnect Switches
 6. Surge Protection Devices
 7. Grounding System
- B. Contractor shall furnish and install a complete lighting system, together with necessary supports, framing, hangers, outlets, fixtures, panels, receptacles, and other appurtenances. Contractor shall furnish and arrange for the setting of anchor bolts, concrete inserts, etc. which are to be set in the concrete or in masonry walls. Work shall include, but is not limited to, the following items:
1. Modifications to existing Lighting Panelboards
 2. Raceway System
 3. Wiring
 4. Wiring Devices and Hardware
 5. Lighting Fixtures and lamp

PART 3 EXECUTION

3.01 DRAWINGS AND MEASUREMENTS

- A. Outlets connected by lines show switch control or circuiting only and are not actual runs of conduit. Light and receptacle outlets are lettered and numbered; the letter indicates the panelboard from which the circuit is to be powered. Outlets bearing the same letter and number shall be connected to the same circuit.
- B. Power feeders shall be run in individual conduits, from source to load, as indicated in schedules, wiring diagrams, or by home runs on the Drawings.

3.02 SHORT CIRCUIT, FLASH HAZARD, AND PROTECTIVE DEVICES COORDINATION ANALYSES

- A. A power system short circuit analysis shall be provided by Contractor to analyze the electrical system and verify the correct application of the power system devices and other power system components provided under this Contract. This and the following flash hazard and coordination analyses shall be carried from the existing MCC through the branch circuit protective devices.
- B. A flash hazard analysis shall be provided by Contractor to determine the flash protection boundary and the level of personal protective equipment (PPE) required for each switch enclosure, panel, device, and equipment containing electrical circuits per NFPA 70E . The results of this analysis shall be used to prepare arc-flash and shock hazard warning labels for electrical equipment enclosures, where required by the National Electrical Code.
- C. A protective devices coordination analysis shall be provided by Contractor to analyze and verify the selection and settings of the protective devices in the electrical system. Devices shall be selected to provide a maximum of circuit protection and selectivity consistent with a maximum in service continuity. Composite coordination curves shall be provided by the Contractor to verify that selectivity will be provided by the devices used.
- D. Provide six (6) bound documents, each of which shall include complete short circuit, flash hazard, and protective devices coordination analyses, including device coordination and time-current curves for the distribution system protective devices.
- E. In the short circuit analysis, provide calculation methods and assumptions, the base quantities selected, one-line diagram, source impedance data (including power company system characteristics), impedance diagrams or data tables, typical calculations, tabulations of calculated quantities and results, conclusions, and recommendations. Provide calculated short circuit interrupting and momentary duties for an assumed three phase bolted fault at the [primary switch, secondary switchboard, the primary switchgear, secondary unit substations, service entrance switch, automatic transfer switch, motor control centers, distribution

panelboards, branch panelboards], and other significant locations throughout the [modified and added] distribution system. Include in the tabulations: fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit kva, and symmetrical and asymmetrical fault currents. Calculations shall be of the per unit impedance method on a 100 Mva or 1,000 kva base.

- F. The flash hazard analysis shall include calculations of the flash protection boundary and incident energy for each piece of electrical equipment utilizing the formulas in NFPA 70E and IEEE 1584. The analysis results shall include the following for each piece of electrical equipment:

1. Nominal System Voltage
2. Arc Flash Boundary in inches.
3. Available Incident energy and the corresponding working distance in calories per square centimeter (cal/cm^2) and/or minimum arc rating of clothing and/or site-specific level of PPE.
4. Limited approach distance (when door or cover is open) in inches.
5. Restricted approach distance (when door or cover is open) in inches.

3.03 SEQUENCE OF CONSTRUCTION AND DEMOLITION

- A. Contractor shall be responsible for coordinating and scheduling work to minimize disruption of Owner's facility operations. Contractor shall schedule service interruptions at times as approved by Owner and shall notify Owner, at least 24 hours in advance, of any scheduled power interruption during construction.
- B. Contractor shall include details of the sequencing of the above work in a schedule of work. The schedule of work shall include work to be performed relative to time of material delivery and length of time for installation and shall be coordinated with permissible outage times as determined by Owner. The schedule shall be submitted for approval prior to the start of work.

END OF SECTION

SECTION 26 05 10

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Requirements specified in Section 26 05 00 - Electrical General Requirements, are part of this Section. This section forms a part of all other sections of Division 26, unless otherwise indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 77 00 - Closeout Procedures
- C. Section 03 30 00 - Cast-in-Place Concrete
- D. Section 26 05 00 - Electrical General Requirements

1.03 SUBMITTALS

- A. Contractor shall submit for Engineer's, approval material lists, shop drawings, and factory test reports, to the extent required in this section and Section 26 05 00.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 77 00 operation and maintenance manuals for items included under this Section.

PART 2 PRODUCTS

2.01 GENERAL

- A. Electrical devices furnished under this Contract will be of the most recent manufacture and received at the job site in the manufacturer's shipping container which clearly identifies the item.
- B. Only new electrical equipment will be acceptable. Used, rebuilt, or discontinued models will not be accepted for installation under this Contract.

2.02 ACCEPTABLE MANUFACTURERS

- A. Only manufacturers recognized as producing new, top quality products meeting applicable standards will be considered acceptable.
- B. Engineer may require Contractor to furnish acceptable material from other sources of supply, if he finds the Work will be delayed or adversely affected in any way because the stated source of supply cannot furnish a satisfactory product in sufficient quantities or if it is known to be unsuitable for the purpose for which it is proposed to be used. Contractor shall have no claim for additional compensation because of such requirement.

2.03 EQUIPMENT AND MATERIALS

- A. Disconnect Switches:
 - 1. Provide heavy-duty rated disconnect switches of the types and ratings, as indicated on the Plans. Disconnect switches for use on 120 VAC systems shall be rated for 240 VAC. Disconnect switches shall be NEMA 4X stainless steel and provided with a pad-lockable operating handle.
 - 2. Disconnect switches shall be manufactured by Square D Co., Allen Bradley, or Eaton.
- B. Lighting Panels:
 - 1. Lighting panels shall be of code gauge steel, of the dead front safety type with single or multi pole circuit breaker branches of the number and size as indicated on the drawings. Lighting panels shall be NEMA 4X stainless steel. Main bus shall be copper. Each panel

shall have a main circuit breaker as indicated on the drawing and have a 10,000 RMS symmetrical interrupting capacity for 240/120 volt panels. Lighting panels shall be Square D, General Electric, or Eaton.

C. Wire Size and Insulation (Low Voltage):

1. Wire for branch circuits, including power and lighting shall consist of No. 12 minimum size copper conductors, insulated with Underwriters' approved 600-volt insulation, and in accordance with the following:
 - a. Rubber and rubber-like insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-19-81 (latest edition), NEMA Publication No. WC3.
 - b. Thermoplastic insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-61-402 (latest edition), NEMA Publication WC5.
 - c. Cross-linked polyethylene insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-66-524 (latest edition), NEMA Publication No. WC7.
 - d. Indoor lighting branch circuits and 120 volt receptacle circuits shall be single conductor solid copper, 600 volt insulation, Type "THW", "THWN", or "XHHW" moisture and heat resistant thermoplastic approved by N.E.C. for operating temperature of 75°C and for installation in wet or dry locations.
 - e. Type "XHHW" heat resistant wire shall be used for wiring of recessed fixtures, and between fixtures and their adjacent outlets.
 - f. For 480 volt standard service, single conductor stranded copper cable shall have corona, ozone, heat and moisture resistant cross-linked polyethylene 600 volt insulation, rated to withstand a copper temperature of 90°C. without deterioration. It shall meet applicable ICEA Standards, and be UL labeled XHHW.
 - g. Wire and cable, including feeders, main and branch circuits, shall be color coded as follows:

208 / 120 Volt		480 / 277 Volt	
Color	Phase	Color	Phase
Black	A	Brown	A
Red	B	Orange	B
Blue	C	Yellow	C
White	Neutral	Gray	Neutral
Green	Ground	Green	Ground

- h. Conductors No. 8 and smaller shall have color coded insulation, Conductors No. 6 and larger shall have terminations and conductors in pull boxes taped with colored tape, not less than two inches wide.
- i. Wire and cable shall be continuous in the same color code and type to its extreme termination point. The use of different type of insulated wire to the same device or equipment will not be accepted. Manufacturers shall be Anaconda, General Cable, General Electric, Okonite, or Triangle.

D. Control Wiring:

1. Control circuit, single conductor field wire shall be No. 14 AWG, stranded copper with 30-mil thick wall of cross-linked polyethylene or polyvinyl chloride insulation rated to withstand a copper temperature of 90 degrees Celsius at 600 volts without deterioration. It shall meet applicable ICEA Standards.

2. Multi-conductor control cable shall consist of individual conductors, No. 14 AWG, stranded copper with 30-mil thick wall of insulation rated to withstand a copper temperature of 75 degrees without deterioration. Insulation shall be a 20-mil wall of polyethylene with a 10-mil thick polyvinyl chloride jacket. Individual conductors shall be identified per Paragraph 5.6.3. of ICEA Publication No. S-61402 and shall be cabled together with suitable fillers and binder tape to give the completed cable a substantially circular cross section.
3. An overall sheath of black polyvinyl chloride shall be applied to the cable and shall not be less than the following thickness:

No. of Conductors	Jacket Thickness
2 - 5	0.045"
6 - 14	0.060"
15 and above	0.080"

4. The entire cable shall meet applicable ICEA Standards and tests for thermoplastic insulated cables.
5. Control wires to be identified with vinyl wire markers.

E. Panel Wiring:

1. Panel wiring shall be a minimum 14 AWG-MTW, 60 degrees rated for AC connections.
2. Thermoplastic wire cover shall be rated at 600 volts and be colored red for AC wires; light blue shall be used for DC wires; canary yellow shall be used for wires interconnecting with other control panels or systems which may be energized from alternate power source; green shall be used on all ground wire connections; black wire shall be used for power source and white shall be used for power neutral.
3. Instrument shields shall be connected to a common ground termination in the control panel. = Shields shall not be grounded in the field.
4. No splices of either control or instrument wiring shall be permitted outside of termination points.
5. Wires comprising the various control systems for this installation shall be identified at each termination with wire identification tags.
6. Numbered tags shall be of the type manufactured of laminated mylar and be capable of withstanding temperatures to 300 degrees Fahrenheit, without deterioration and discoloration.
7. Each wire number shall be "solid" preprinted and not pieced from single and/or double-digit tags.

F. Shielded Single Pair Cable:

1. For general shielded service, single-pair cables shall consist of two conductors, twisted together, served with a continuous aluminum mylar shield with grounding bleed wire and protected with an insulating jacket.
2. Individual conductors shall consist of a tinned, soft annealed copper conductor, stranded, insulated with a 24-mil thick wall of polyethylene. The twisted pair shall be color coded and sized as follows:
 - a. Runs under 400 feet - No. 16 AWG
 - b. Over 400 feet - No. 14 AWG

G. Multiple Conductor Shielded Cable:

1. Cable construction shall be an assembly of twisted pairs cabled together and served with an overall aluminum mylar shield with grounding bleed wire, with an extruded jacket of polyvinyl chloride having a thickness as follows:

Cable Size	Jacket
3 and 7 pair	60 mils

2. Portable cords shall consist of flexible, bunch stranded, plain annealed copper conductors with a 600-volt heat and moisture resistant rubber insulation suitable for operation with a 60 degrees Celsius copper temperature. Individual conductors shall be color coded for identification and cabled with suitable high strength fillers to give the completed cable a circular cross section.

H. Conduits and Fittings:

1. Conduits shall be manufactured in conformance with the latest published standards of ANSI, ASTM, and UL and shall be as follows:
2. Rigid steel conduit, conduit bends, elbows, couplings, and nipples shall be hot-dipped galvanized. Buried rigid steel conduit shall be plastic coated galvanized steel conduit. Couplings and connectors shall be threaded type.
3. Conduit terminations shall consist of double locknuts and insulated bushing, raintight connectors, or threaded hubs as applicable to maintain the rating of the enclosure to which it is being terminated.
4. Joints in conduits shall be made with standard couplings unless neither conduit can be turned; then, union shall be made with O.Z. Type "SP" split coupling or Erickson couplings. Running threads are not permitted.
5. Conduit expansion fittings shall be O.Z. Type "DX" with bonding jumper, as required.
6. PVC conduit material shall have tensile strength of 7,000 psi at 73.4 degrees Fahrenheit, flexural strength of 11,000 psi, and compressive strength of 8,600 psi.
7. PVC conduit fittings and covers shall be of the same manufacturer as the PVC conduit.
8. Flexible liquid tight conduit shall be provided for connections to vibrating or rotating equipment. Conduit shall be Anaconda Type "UA" for 3/4-inch to 1-1/4 inch and Type "EF" for 1-1/2-inch and larger, flexible conduit, with Appleton STN series fittings, as required.
9. Flexible steel conduit similar to "Greenfield" shall not be permitted.

I. Pull Boxes:

1. Pull boxes, junction boxes, and cable support boxes of proper size and design shall be provided in accordance with the N.E.C. and as required to facilitate installation of wires. Boxes shall be sized in accordance with the N.E.C. Covers shall be gasketed and held in place with corrosion resistant machine screws. Cable supports for vertical runs shall be provided at code required locations, within pull or junction boxes. Boxes shall be NEMA 12 for inside and NEMA 4X for outside use where exposed to the weather or where otherwise called for on the drawings.

J. Outlet Boxes:

1. Cast steel outlet boxes shall be used for every outlet and switch where called for on the drawings and as herein specified. Cast boxes shall meet the requirements for galvanized finish specified for steel conduits.
2. Outlet boxes for exposed work shall be of cast steel construction with threaded openings Type "FS" or "FD" unless noted otherwise.
3. Provide temporary caps on boxes similar to Gedney, "Red Caps" during construction.

K. Receptacles:

1. In general, the receptacles shall be duplex convenience grounding type with weathertight gasket and covers and shall be installed in exposed cast metal conduit boxes type FD with mounting ears. This also includes receptacles used for disconnects.
2. Convenience receptacles shall be rated 20 amps with back and side wiring and with exposed metal parts finished to resist corrosion.
3. Special purpose receptacles shall be rated 20 amps, 230 volt, unless otherwise called for on the drawings.
4. Weatherproof duplex receptacles shall have a separate spring type cover for each receptacle mounted on a FS or FD box.
5. Receptacles in wet well, kitchens, bathrooms, and as indicated on the drawings shall be provided with ground fault circuit interrupting breakers.
6. Explosion proof receptacles shall be 20 ampere, 2 wire, 3 pole, 120 volts, Killark KRS-215-220 Appleton Crouse-Hinds. Supply one matching plug each.

L. Light Switches:

1. Switches shall be "T" rated. Switches, and receptacles shall be specification grade and as called for on the drawings.
2. Covers shall be stainless steel unless otherwise called for on the drawings.
3. Switch and Receptacle Plates:
4. Plates for switch, receptacles, telephone, and miscellaneous signal outlets shall be 0.040 inches stainless steel with No. 4 finish in all areas unless otherwise noted.
5. Cadmium plated steel plates shall be installed in equipment space and process areas.
6. Grouped devices shall be mounted in a single continuous gang plate.

M. Lighting Fixtures:

1. Contractor shall furnish all materials and equipment required to install and place in operation all LED fixtures.
2. Lighting fixtures shall be complete, including all lamps and/or tubes, ballasts, fuses, support brackets and other parts and devices necessary for complete operation.
3. The lighting fixtures shall be as listed on the Plans. Other manufactures may be acceptable if approved by Engineer in accordance with the requirements for "substitutes" in the General Conditions.
4. Lighting fixture supports and conduit connections and fittings shall have corrosion resistant qualities.
5. Fixtures, signs, etc., shall carry the approval of the Underwriters Laboratories, Inc., and be so labeled.

N. Heat Trace System:

1. Heat trace cable shall be 120 VAC, 5 watts/ft., furnished with heat trace controller and ground-fault protection device (as required per the NEC). Heat trace cable shall be manufactured by Chromalox CPR series or equal. Heat trace controller shall be manufactured by Chromalox TPR series or equal.

O. Telephone Box and Handset:

1. Telephone box shall be NEMA 4X, surface mount, with latching door. The telephone box and handset shall be manufactured by Hubbell/GAI-Tronics Model 354-001 or equal.

P. Nameplates:

1. Safety switches, lighting panels, starter enclosures, panelboards, etc., nameplates shall be of laminated white plastic with black lettering and shall be attached with sheet metal screws. Nameplates size shall be 2-1/2-inch wide x 3/4-inch high. First line character size 1/4-inch high, second line 3/16-inch high. For panel designations, refer to electrical panel schedule on drawings. Panelboards shall contain a typed circuit schedule inside of cover.
2. Field located instruments and devices shall be equipped and identified with 1" x 3" engraved nameplates (similar to the panelboard nameplates) and affixed to their respective devices in a positive but flexible method (wire strap or other similar means).

2.04 MIXES

- A. Patches, conduit sealing compound, fire stop compounds, etc., shall be mixed in accordance with the manufacturer's recommendations.

2.05 FABRICATION AND MANUFACTURE

- A. Contractor shall, to the degree possible, preassemble switchgear, panel boards, motor control centers, control panels, relay panels, etc.
1. Preassembly should be done off site in a clean shop environment by Contractor or manufacturer.
- B. Control panels, motor control centers, and switchgear shall be fabricated in sections not exceeding 10 feet in length and provided with jumpers for field connections of bus and interconnecting wiring.
1. Panels shall be provided with adequate lifting eyes.

PART 3 EXECUTION

3.01 VERIFICATION

- A. General:
1. Dimensions which tie mechanical and/or electrical installations to the building structure shall be thoroughly field checked for accuracy and possibility of interference due to field conditions. Ignorance of such field conditions because of Contractor's failure to field check the dimensions in question will be no excuse for additional compensation.
- B. Surveys:
1. Contractor shall lay out and establish the lines and grades of all underground conduits on the site in accordance with the drawings and he shall employ a competent surveyor for this portion of the work.
 2. In the event of unforeseen obstructions, Contractor shall confer with Engineer and obtain his written approval before proceeding with any work deviating from the governing drawings. Contractor shall assume full responsibility for locations and grades throughout this portion of the Work.
- C. Locations:
1. Wall outlets, telephone outlets, clock outlets, specialized outlets, fixtures, and equipment rough-ins shall be field located except as otherwise shown on the drawings.
- D. Points of Termination:
1. The points of connection and termination of related work under this Division of this Project are indicated on the Plans or stated in the Specifications, but in case of doubt as to such points of connection or termination, the decision of Engineer shall be final.

3.02 PREPARATION

- A. Conduit, fittings, and accessories shall be free of foreign matter. Conduit ends shall be reamed and deburred to prevent damage to the wire and cable.

3.03 INSTALLATION

A. General Requirements:

1. Electrical system layouts indicated on the Plans are generally diagrammatic and locations of outlets and equipment are approximate. Exact routing of conduits and wiring, locations of outlets and equipment shall be governed by structural conditions and obstructions. Equipment requiring maintenance shall be located and installed so that it shall be readily accessible.
2. Contractor shall not burn, cut or drill structural steel for the installation of conduit in any manner except where written permission is granted by Engineer.
3. Wiring shall be installed in raceway, including low voltage work, except where otherwise shown or specified.
4. Minimum conduit size shall be 3/4-inch unless noted otherwise.
5. Conduit shall be installed to be concealed wherever possible, unless otherwise indicated. In unfinished mechanical equipment rooms where the exact location of ventilation ducts, etc., is not shown, install the conduit exposed and avoid interferences.
6. Conduits shall be separated by at least 12 inches from parallel runs of steam or hot water piping.
7. Rigid steel conduit shall be used for exposed service drops in mechanical equipment and process area rooms, in exposed outdoor areas, except where another type of raceway is specified. Locknuts shall be steel or malleable iron (as size requires).
8. Conduit runs in floor slabs and direct buried underground between structures shall be rigid steel. Stub ups shall be rigid steel.
9. Where PVC conduit is permitted as noted on drawings, underground PVC conduit runs shall be installed on approved plastic spacers and encased in a 3-inch Granular Material envelope with red-oxide pigmented concrete over top. Envelopes shall have a yellow-colored, plastic, detectable caution tape buried a minimum of 12-inches above the conduit. Caution tape shall be labeled "Caution – Buried Electrical Lines".
10. Connections to vibrating or rotating equipment shall be made with flexible liquid tight conduit.
11. Provide expansion fittings at all expansion joints and/or where required to compensate for expansion and contraction in long conduit runs. Connectors shall be compatible with flexible conduit used.
12. Conduits shall be installed in floors and walls, wherever possible, unless otherwise indicated on the Plans or specified herein.
13. Empty feeder and riser conduits shall contain one No. 10 AWG galvanized steel pull wire. Splicing of the pull wire will not be permitted.
14. Conduit joints shall be set up tight. Runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical.
15. Multiple conduit runs exposed shall be mounted with rustproofed steel supports arranged so that each conduit is individually clamped or bolted. Steel conduit supports shall be hot-dipped galvanized after fabrication.

16. Concealed conduits or outlets installed flush in masonry or concrete construction shall be rigidly braced against movement during the construction period to ensure accurate termination points.
17. Conduits hidden by suspended ceilings may be run exposed between ceiling construction and structural slab. Conduits, where exposed in service rooms, mechanical equipment rooms, etc., and other work areas, shall be racked in neat symmetrical lines with proper supports. Conduits shall be run at right angles and parallel to floors, ceilings, and walls.
18. Underground conduit shall be tested to determine that all fittings are completely sealed. The tests shall be performed during and after installation of conduit, but before cable is pulled and before any conduit is encased in concrete.
19. Ninety (90) degree bends 1-1/4 inches and larger shall be made with factory elbows. Elbows of 3-inch conduit size and larger shall be long radius. Field bends shall be made so that the conduit will not be injured and the internal diameter shall not be effectively reduced. Factory elbows, nipples, and couplings shall be the same type as the conduit with which they are used.

B. Conduit Supports:

1. Conduit supports shall be suitably spaced and secured so as to provide adequate mechanical support and shall meet the code requirements. Supports shall be of steel bar, unistrut, angle or channel and of a size to provide a firm, rigid support. Fabricated supports and mounting brackets shall be hot dip galvanized after fabrication and drilling is complete. Rod hangers may be used when laterally braced. Structural steel flanges of I beams or channels shall not be drilled. Prefabricated sections may be used with approval of Engineer.
2. Electrical equipment including raceways, outlet boxes, panels, fixtures, etc., shall be substantially secured to the building structure. Inserts or insert bolts for support of the electrical equipment shall be installed during the building construction wherever practical.
3. Exposed multiple horizontal and vertical parallel runs of conduit shall consist of galvanized steel framing channels, conduit clamps, and rod hangers, where required, installed in accordance with the manufacturer's recommendation for the carried loads.
4. Where exposed isolated conduit needs clamping to flat surfaces, clamps shall consist of galvanized malleable iron, one-hole pipe straps for conduit up to and including 1-1/2 inches. Straps for conduits above 1-1/2 inches shall be two-hole, extra heavy steel. Steel bolts of appropriate size to fill the holes of the straps shall be used.
5. Conduit shall be supported in accordance with N.E.C.

C. Conduit Fittings:

1. Conduit fittings shall be made of a compatible material as the conduit. Conduit fittings with blank covers shall have rubber gaskets except in clean, dry areas and shall be accessible after the Work is completed.

D. Sleeves and Inserts:

1. Contractor shall provide all openings and sleeves on walls and floors as required for his work. Inserts shall be the tapered nut type with lead alloy expansive retainer sleeve. The use of wooden plugs will not be permitted.

E. Lighting:

1. Lighting fixtures shall be mounted level at the height as indicated on the Plans.

F. Taps and Splices:

1. Splices and taps shall be made by means of screw type pressure connectors. Spring pressure type connectors may be used for No. 10 AWG conductors and smaller. Instrument pigtail splices shall be made with solderless crimp type connectors.
2. Connections for No. 8 wire and larger to switches, panels, and controllers shall be made with solderless lugs of proper style and size to handle full wire capacity.
3. Stranded cable terminations shall be equipped with solderless lugs.
4. No splices outside of enclosures will be allowed. No splices except for lighting fixture and instrument pigtail connections shall be permitted unless specifically indicated on the Plans or written approval is given by Engineer.
5. Joints not supported and enclosed on terminal strips or equipment lugs shall be insulated with high-quality tape or material in an approved manner.

G. Wiring:

1. Wiring for power, lighting, telephone, sound, and low voltage control shall be run in one of the types of conduit described in these Specifications, unless indicated otherwise on the Plans.
2. Multi-wire branch circuits shall be color coded as stipulated in the National Electrical Code, and as herein specified.
3. Circuits feeding duplicate processing equipment shall be installed in separate conduits.
4. Instrumentation cable shall be run in conduits so as to isolate the cable from power or electrical wiring.
5. Cable insulation shall not be cut back beyond what is reasonably required to make connection, splice, or termination.
6. Wires and cables shall be tagged at both ends and in pull boxes or panel box gutters they pass through.
7. No conductors shall be pulled into any conduit run before all joints are made up tightly and the entire run rigidly secured in place.
8. Approved pulling-in compounds shall be permitted for ease of pulling cables. Pulling of cables shall in no way cause injury to conductors by elongation or to insulation by abrasion, binding, etc. Damaged cable shall be replaced.

H. Foundations:

1. The electrical subcontractor shall arrange with Contractor to provide concrete pad foundations for all floor-mounted equipment installed under this Division. Pad shall be four inches high, unless noted otherwise.

I. Access Panels:

1. Access panels or hatches shall be provided wherever electrical equipment concealed by the building construction requires access for inspection, operation, or maintenance. Contractor shall furnish all such panels required for access to Contractor's work. Contractor shall install all panels.
2. A subcontractor requiring access panels shall confer with Contractor in regard to access panel locations and shall, wherever practicable, group equipment requiring access such that a single panel will serve all and eliminate additional panels.

J. Grounding:

1. Contractor is responsible for providing all grounding, whether or not shown on the Plans, and all grounding shall be provided in accordance with NEC and local codes and ordinances. Grounding as shown on the plans is the minimum acceptable. Electrical

grounding shall be grouped into two (2) classifications as follows: system grounding and equipment grounding.

a. System:

- 1) Use of the metallic conduit or fittings or piping as a grounding path shall not be acceptable.

b. Equipment:

- 1) Metal or conducting type enclosure frames, raceways, cable trays, conduit, panelboards, substation, motor frames, switches, switch boxes, outlet boxes, junction boxes, lighting fixture frames, building steel, metal siding, rebar, piping, etc., shall be grounded by a green colored or bare equipment grounding conductor of size called for in tables of the most recent applicable N.E.C. edition.
- 2) When a separate equipment grounding conductor is used, it must be contained within the same raceway or cable with the circuit conductors.
- 3) Grounding rods, hereinafter referred to as ground rods, shall be solid cylindrical rods, 3/4-inch in diameter and 10 feet in length, or longer, as required to reach specified resistance. Rods shall be of copper-clad steel tinned at top end for connection.
- 4) Resistance from the building ground loop to earth before connection to the building steel and the water system shall not exceed 2 ohms.
- 5) Bare copper bar, cables, or fittings used for grounding shall not be installed in cinder fill or covered with soil containing cinders or other corrosive materials. Cables shall be installed with enough slack to prevent stresses.
- 6) Where ground conductors pass through floor slabs, building walls, etc., and are not encased in rigid metal conduit as specified elsewhere, shall be provided with sleeves of transit, plastic, fiber or other approved nonmetallic material, and of the required size, shape, and length unless otherwise specified or indicated on the Plans.
- 7) Bonding jumpers shall be copper and of a cross-sectional area at least equal to their corresponding grounding conductors. Where attached to equipment, conduits, cabinets, etc., suitable approved solderless lugs, compression connectors or clamps shall be used. No soldered connections shall be used on grounding circuits at any point, except where ground conductors are attached to lead cable sheaths.
- 8) Grounding mediums shall be bonded together. This shall include electric, telephone, antenna systems, ground and underground piping systems which enter the structure.
- 9) Compression connectors, lugs, etc., used in grounding circuits in any location shall have bolts, nuts, etc., of silicone bronze alloy metal. Ground connections, clamps, etc., shall be as manufactured by Burndy Engineering Company, Thomas & Betts Company, or Penn-Union Electric Company.
- 10) The minimum number, spacing, and location of ground rods to be driven shall be per the site soil conditions during dry weather. Connections to ground rods shall be below finished grade level and shall be connected by a "cadweld", or other thermal process.
- 11) Use of the water system as the grounding electrode shall not be acceptable. However, the water system shall be grounded to the grounding system.

- 12) Taps and splices in grounding cables shall be made by the "cadweld", or equal process.
- 13) Conduits which run to boxes or cabinets having concentric or eccentric knock-outs which partially perforate the metal around the conduit and impair the electrical connection to ground shall be provided with approved bonding jumpers. Jumpers shall consist of a stranded, braided copper wire at least No. 6 AWG with solderless lug on each end. Jumper shall be connected inside the box to a stud or silicone bronze alloy bolt in the cabinet frame.
- 14) Conduit expansion joints and telescoping sections of metal raceways not thoroughly bonded otherwise shall be provided with approved bonding jumpers of not less than No. 6 AWG stranded bare copper.

K. Electrical Equipment Identification:

1. Electrical devices shall be labeled in a clear and permanent manner to identify its electrical circuit.
2. Motor circuits shall have the functional description on motor starter panel and distribution panelboard doors, remote safety switches and manual switches.
3. Receptacles and wall switches shall be identified using the distribution panel "letter designation" and circuit breaker numerical assignment.
4. Motor starters, switch boards, and panelboards shall have laminated plastic identification nameplates attached to the unit with screws as specified herein. Other electrical devices shall be identified using 1/4-inch plastic adhesive-backed embossed tape securely fastened to the face of the device.

L. Painting and Finishing:

1. Concealed iron work, panel boxes, junction and pull boxes, and support boxes not galvanized shall be given one coat of rust resisting paint inside and out. In addition, junction boxes shall be given one coat of white enamel inside only.
2. Equipment which was finish painted by the manufacturer or fabricator shall remain as is unless paint has become marred or damaged during installation, in which case the equipment shall be repainted to its original condition by Contractor.

3.04 FIELD QUALITY CONTROL

A. Requirements of Regulatory Agencies:

1. Materials and equipment required for the work and the installation shall conform to all national, state, and local codes, rules, regulations, and ordinances. Contractor shall secure all permits, inspections, and tests required in connection with his portion of the Project.

B. Tests:

1. After the installation of apparatus and wiring has been completed, all electrical conductors shall be tested by Contractor to ensure continuity, phasing, proper splicing, freedom from unwanted grounds, and insulation values.
2. A 1,000-volt hand-driven megger shall be used on all 600 volt insulated service conductors and a 500-volt hand-driven megger may be used on all lower voltage insulated service conductors. Conductors shall be isolated from other equipment during test and each cable shall be tested until reaching a constant value for 15 seconds.
3. Megger and high potential tests of multiple conductor cables shall be applied between one conductor and ground with all other conductors connected to the same ground. Each conductor shall be tested in like manner.

4. Wiring not measuring up to minimum ICEA field testing standards shall be replaced.
5. Minimum acceptable reading is 100 megohms for 600 volt insulated service conductors and 1.0 megohms for lower voltage insulated services such as instrumentation cables.
6. Tests shall be made with lightning arrestors removed and disconnections made at points of final termination.
7. Motor rotation shall be checked with the motor disconnected mechanically from equipment to be driven, to prevent damage to the equipment. Motor rotation shall be as directed by the equipment manufacturer and shall be checked for accuracy in cooperation with the manufacturer.
8. Do not test the equipment unless it is sufficiently lubricated.
 - a. Testing on Grounding:
 - 1) Inspect ground conductors and connections for conformance with design specifications and for satisfactory workmanship.
 - 2) Test resistance to earth of each ground rod and each ground grid.
 - 3) Test ground paths for equipment and structural steel grounding.
 - b. Maintain each ground rod isolated from the associated ground grid for tests on individual rods for resistance to earth.
 - c. Include associated ground rods and interconnecting wiring in tests on each grid system for resistance to earth.
 - d. Include ground bus on equipment, grid connection, and associated intermediate copper ground conductors in tests on ground paths for electrical equipment.
 - e. Include structural steel connection, grid connection and intermediate conductor in tests on ground paths for structural steel.
 - f. Test each ground rod for resistance to earth by a standard method. Use a Biddle ground tester or the method of using two auxiliary ground rods as described in IEEE Standard No. 550, paragraph 3.42. The IEEE method requires the use of AC test current. Place auxiliary test rods sufficiently far away from the rod under test so that the regions in which their resistance is localized do not overlap. Calculate ground resistance from the readings taken. Maximum acceptable resistance to earth at each ground rod: 25 ohms.
 - g. If the resistance is found to be higher than 25 ohms, drive additional rods with a minimum separation of 10 feet and connect in parallel with the rod under test until 25 ohms or less is obtained, or increase the length of the rod under test until 25 ohms maximum is obtained.
 - h. Test each isolated ground grid as specified for individual ground rods, except the maximum acceptable resistance to earth is five ohms. In tests on total ground systems, the maximum acceptable resistance to earth is two ohms.
 - i. Test ground paths for electrical equipment and structural steel for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes. The ground path for electrical equipment using structural steel must conduct 100 amperes. Resistance as calculated from the current and voltage must not exceed 0.010 ohms.
 - j. Grounding materials and connections must pass all inspections and must meet all specified maximum and minimum values.
 - k. Make complete records of all tests. Include resistance values obtained, calculations of same, and methods of test and calculation.

9. Notice of tests to be performed shall be sent to Engineer and Owner before tests are made.
10. Duplicate certified records of all insulation tests shall be furnished to Engineer.

3.05 ADJUSTING AND CLEANING

A. Adjustments:

1. Contractor shall be responsible for making any equipment and instrument adjustments necessary to provide a complete and safe working system under normal operating conditions.
 - a. Equipment to be adjusted shall include, but not limited to, ground fault circuit interrupters, circuit breaker trip settings, motor starter overload settings, thermostats, pressure switches, level switches, limit switches, control instruments, etc.
 - b. Contractor shall provide a coordination study of the electrical system.

B. Manufacturer's Services:

1. Services of a factory trained, qualified service representative of the equipment manufacturer shall be provided by Contractor to inspect the complete equipment installation to ensure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system in trouble-free operation, and instruct the operating personnel in the proper care and operation of the equipment furnished. This will be required for the main switch gear/motor control center, main control panel including all instrumentation and any other major equipment.

C. Cleaning and Finishing:

1. Before turning the systems over to Owner, clean all fixtures, equipment, exposed metal surfaces, and leave all in clean condition at the end of the Work as specified elsewhere in the Contract Documents.

D. Final Inspection:

1. Upon completion of the Work, Contractor shall conduct a complete inspection of all items of Work and make whatever corrections and adjustments are deemed necessary to a well functioning system that will meet with the satisfaction of Engineer and Owner.

END OF SECTION

SECTION 26 05 23 INSTRUMENTATION CABLE AND WIRE

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required to provide instrumentation cable for use in raceways, cable trays, conduit, cabinets, consoles, panels and enclosures as shown on the Drawings, specified or required.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding Systems
 - 2. Section 26 05 33 - Raceways and Boxes
 - 3. Section 26 05 36 - Cable Tray Systems
 - 4. Section 26 05 53 - Electrical Identification
 - 5. Section 26 27 27 - Terminations and Terminal Devices

1.02 REFERENCE STANDARDS

- A. Reference Standards:
 - 1. ANSI MC96.1, Temperature Measurement Thermocouples
 - 2. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 3. ICEA S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables
 - 4. NEMA WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables
 - 5. UL 13, UL Standard for Safety Power-Limited Circuit Cables
 - 6. NFPA 70, National Electrical Code (NEC)
 - 7. UL 1277, UL Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

1.03 SUBMITTALS

- A. Product Data: Manufacturer's Literature and Engineering Data.
- B. Quality Assurance Submittals: Field Test Reports.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. No outside storage shall be allowed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Belden
- B. Alpha Wire Company
- C. Dekoron Wire & Cable Company
- D. Approved Equal

2.02 MATERIALS

- A. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 BTU per hour and NFPA 70 article 340 or UL 13 meeting requirements of NFPA 70 article 725.
- B. Voltage for Instrumentation cable: Shielded Instrumentation cable shall be rated 600 V unless otherwise shown on the Drawings or specified.
- C. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
 - 1. Outer Jacket: 45-mil nominal thickness
 - 2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
 - 3. Dimension: 0.31-inch nominal OD.
 - 4. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
 - b. 16 AWG, seven-strand tinned copper drain wire
 - c. Insulation: 15-mil nominal PVC
 - d. Jacket: 4-mil nominal nylon
 - e. Color Code: Pair conductors, black and red or clear.
- D. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
 - 1. Outer Jacket: 45-mil nominal.
 - 2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
 - 3. Dimension: 0.32-inch nominal OD.
 - 4. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
 - b. 18 AWG, seven-strand, tinned copper drain wire
 - c. Insulation: 15-mil nominal PVC
 - d. Jacket: 4-mil nylon
 - e. Color Code: Triad conductors black, red, and blue
- E. 18 AWG, Multi-twisted Shielded Pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.
 - 1. Outer Jacket .45 mil nominal
 - 2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
 - 3. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8

- b. Tinned copper drain wires
 - c. Pair drain wire size AWG 20, group drain wire size AWG 18
 - d. Insulation: 15-mil PVC
 - e. Jacket: 4-mil nylon
 - f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification
 - g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer
- F. Control Net Cable
- 1. RG-6/UType Coaxial Cable.
 - 2. The cable shall consist of an 18 AWG solid bare copper covered steel conductor, foam polyethylene insulated, with a 4-layer shield: 100% aluminum-polyester, 60% tinned copper braided, 100% aluminum-polyester, 40% tinned copper braided, with an overall PVC jacket.
 - 3. If plenum rating is required, cable insulation shall be foam fluorinated ethylene propylene and jacket shall be fluorocopolymer, instead of insulation and jacket materials listed above.
 - 4. If any portion of the cable run is not contained in conduit or an appropriate enclosure, cable shall be plenum or riser listed and marked as required by NEC 800-Communications Circuits.
 - 5. Manufacturer: Provide one of the following:
 - a. Allen-Bradley 1786-RG6
 - b. Belden 3092A
 - c. Belden 3093A (plenum rated)
 - d. Approved equal

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and terminate vendor furnished cable in accordance with vendor equipment requirements and cable manufacturer's specific recommendations.
- B. Thermocouple wire shall be directly connected between the thermocouple element and the transmitter or input device. Should any junctions be made, terminal blocks compatible with thermocouple shall be used to maintain temperature integrity. Splices shall not be acceptable.
- C. Ground Shield on shielded cables at 1 end only. Unless otherwise shown on Drawings, ground shield in process control panel.
- D. Identification and color coding meeting the requirements of Section 26 05 53 - Electrical Identification, shall be provided for all conductors.
- E. Installation of shielded cable shall have clear heat shrink sleeve over drain wire and heat shrink over the cable breakout jacket end (to prevent raveling).

3.02 FIELD QUALITY CONTROL

- A. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.
- B. Testing report sheets shall be maintained. Report sheets shall identify each cable and conductor tested by its unique identification number and the circuit of which the cable and

conductor is a part. Continuity shall be recorded. Test reports shall be signed by the tester, and initialed by the Engineer.

- C. Defective new cables shall be replaced by Contractor at Contractor's expense for the full length of the cable.
- D. All test equipment and material shall be provided by the Contractor.

END OF SECTION

SECTION 26 05 26 GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required to provide a complete grounding system for the electrical and instrumentation system as shown on the Drawings, specified or required, including:
 - 1. Grounding electrodes and conductors.
 - 2. Equipment grounding conductors.
 - 3. Bonding.
 - 4. Metal underground utility piping.
 - 5. Metal frame of the building.
 - 6. Ground loops, risers, and conductors.
 - 7. Rod electrodes.
 - 8. Ground mat.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 07 05 - Electrical Test Certificates

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Complete layout and location plans of the grounding electrode system and main grounding conductors.
 - 2. Material schedule of components proposed for use.
 - 3. Instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.
- B. Product Data: Manufacturer's Specifications, Technical Data, Dimensional Data, and installation instructions for components proposed for use under this Section.
- C. Quality Assurance: Test Certificates
- D. Project Record Documents: The following documentation shall be provided in accordance with Section 01 77 00 - Closeout Procedures:
 - 1. Complete as-installed layout and location plans of the grounding electrode system and main grounding conductors.

1.05 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms.
- B. In the event that the ground resistance is not 5 ohms or less, additional rods or longer rods shall be installed or the soil treated to reduce its resistance by approved practices. ground

resistance measurements shall be made using the fall-of-potential method only and test reports shall be provided as specified.

- C. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 ROD ELECTRODES

- A. Ground rods shall be 3/4-inch diameter by 10 feet long and shall have copper jackets and steel cores. Rods shall be as manufactured by Blackburn/Eritech, Erico Electrical Products, Harger, or equal.

2.02 MECHANICAL CONNECTORS

- A. Compression connectors, lugs, etc., used in grounding circuits in any location shall have bolts, nuts, etc., of silicon bronze alloy equal to "Everdur" metal. Grounding connections, clamps, etc., shall be as manufactured by Burndy Engineering Company, Thomas and Betts Company, Delta-Star Electric Company, Harger, or equal.
- B. Fittings for bonding a grounding conductor to metallic conduit shall be Thomas and Betts Series 3900BU or equal. Fittings for bonding a grounding conductor to its own conduit shall be Burndy Engineering Company GAR-BU Series, Thomas and Betts Series 3900, Harger, or equal.
- C. Where connections to ground rods or ground mats must be disconnected for testing, the fittings shall be Burndy Engineering Co. Type GD, GG, GAR; Thomas and Betts Co. Series 3902BU; Harger; or equal.

2.03 EXOTHERMIC CONNECTIONS

- A. Connections to steel, between conductors, and for water stops shall consist of exothermic welding similar and equal to Burndy Engineering Company's "Thermoweld", Erico Products, Inc. "Cadweld Kits", Thomas & Betts Corp. "Furseweld", or Harger.

2.04 CONDUCTORS

- A. Grounding conductors, loops, and risers shall be bare, stranded, soft-drawn copper and shall be of the sizes indicated on Drawings.
- B. Bonding jumpers shall be copper and of a cross-sectional area at least equal to their corresponding grounding conductors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that final backfill, and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground. Rod electrodes shall be driven into undisturbed earth or engineered backfill only.
- C. Provide bonding to meet Regulatory Requirements.
- D. The non-current carrying parts of all electrical equipment installed under this Contract, including but not limited to raceways, raceway supports, and equipment enclosures, shall be bonded by means of bare copper cable or copper strap to the grounding system as shown on the Drawings and specified hereinafter.

- E. Underground, metallic, service piping (water, gas, etc.) shall be solidly connected to the building grounding system with a No. 4/0 AWG grounding conductor (minimum) at the piping's entrance to the building.
- F. Exposed, including painted or coated, structural and architectural metal shall be bonded to the grounding system or rigidly secured to and in good electrical contact with grounded metal.
- G. Grounding cables, bus, etc., in locations where subject to mechanical damage, shall be protected by rigid metal conduit, steel guards, non-metallic conduit, or other suitable shield. Where conduit or other metallic encasement of grounding conductors is required, the conductor shall be permanently and effectively grounded to the enclosure at both ends of its length. This requirement applies to enclosures regardless of their length.
- H. Where grounding conductors pass through floor slabs, building walls, etc., and are not encased in the concrete pour, sleeves of rigid metal conduit or non-metallic conduit of the required size, shape, and length shall be provided with both ends of the sleeve sealed with duct seal after installation of the grounding conductor.
- I. Where grounding conductors pass through a concrete pour (encased), from underground to the interior of a structure, an exothermic water stop shall be provided on the grounding conductor within the pour.
- J. Where attached to equipment, conduits, cabinets, etc., suitable approved solderless lugs, compression connectors, or clamps shall be used. No soldered connections shall be used on grounding circuits at any point.
- K. Where a grounding cable is to be bonded to structural or architectural metal, the exact location of each bond shall be approved by Owner. The location of such grounding connections shall be at points where they will not be subject to mechanical damage and, if possible, shall be accessible for inspection.
- L. Where welding to steel is prohibited, the grounding conductor shall be bolted directly to the steel as approved by Owner. The contact surfaces of bolted connections shall be thoroughly cleaned and coated with Alcoa No. 2 Electrical Joint Compound or equal.
- M. Taps and splices in grounding cables and connections to ground rods shall be made by an exothermic weld process.
- N. Metal ducts, conduits, starters, panels, switches, etc., which are not rigidly secured to and in good electrical contact with the grounded structural metal frame of the building or grounded conduit system, or which are subject to excessive vibration and loosened ground contacts, shall be securely bonded to grounded building steel or to the grounded conduit system by means of stranded copper jumpers. This jumper shall have a circular-mil cross section of not less than 50 percent of that of the largest conductor entering the enclosure being grounded, with a minimum size of No. 8 AWG stranded copper being used in any jumper.
- O. Conduits which run to boxes or cabinets having concentric or eccentric knockouts which partially perforate the metal around the conduit and impair the electrical connection to ground shall be provided with approved bonding jumpers. Jumpers shall consist of a stranded, braided copper wire at least No. 8 AWG with solderless indent type lugs. Jumper shall be connected from a grounding type locknut or bushing on the conduit inside the box to a stud or silicon bronze alloy bolt in the cabinet frame.
- P. Metal support racks for electrical equipment and enclosures shall be securely bonded to grounded building steel or the grounding system with a No. 2 AWG grounding conductor.
- Q. A copper ground conductor shall be carried for each power, lighting at 120 volts and higher, and receptacle circuit with the circuit conductors. The ground conductor shall have the same type insulation as the circuit conductors and shall be green in color through No. 10 AWG and bare copper wire for larger sizes.

- R. Switchgear, motor control center, distribution panelboard, and automatic transfer switch grounding shall consist of ground connections to feeder conduits, ground busses, etc. as required or as indicated on the Drawings.
- S. Splices in wire or cable ground leads shall not be permitted.

3.03 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required to provide supporting systems for equipment, boxes, cabinets, consoles, panels, enclosures, conduit, cable tray, wireway, busway, and cablebus as shown on the Drawings, specified or required.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electric Code

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Drawings, including capacity and loading calculations for support systems.
 - 2. Detail dimensions.
 - 3. Bills of Materials.
- B. Product Data:
 - 1. Copies of manufacturer's specifications including material, dimensional and weight data and load capacity for each supporting system component proposed for use.
 - 2. Pictorial views and corresponding identifying text of each component proposed for installation.

1.04 QUALITY ASSURANCE

- A. Designs and drawings, including capacity and loading calculations for support systems shall be prepared a professional engineer registered in the State of Michigan.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Conduit and equipment supports and hangers shall be made of galvanized structural steel, with welded or bolted joints. Conduit and equipment supports and hangers shall be fabricated from "Unistrut" Series P1000 galvanized channels and fittings, as manufactured by the Unistrut Products Company, Superstrut A-1200 Series, Grinnell "Power-Strut" PS-200, or equal.
- D. Conduit and equipment supports, hangers, beam clamps (no "C" clamps shall be allowed), and other similar devices made of steel shall be hot dipped galvanized or sherardized after fabrication. All hanger rods, U-bolts, bolts, nuts, and other threaded support components shall be electro-galvanized (per ASTM-B633 Type III SC1) or sherardized. Field cuts and all welds shall be coated with an approved cold or hot galvanizing compound: Z.R.C., CRC Chemicals Zinc-It, or equal. All hanger rods shall be 3/8-inch diameter, minimum. All such hardware shall be factory encased with polyvinyl chloride (PVC) of minimum 0.040-inch (40 mil) thickness where indicated on the Drawings and where specified elsewhere. All touch-up required in the field shall be in strict accordance with the manufacturer's printed instructions.

- E. Concrete inserts shall be of the continuous channel or spot type. The channel type shall be No. 12 gauge steel with integral anchors, Super Strut No. C-302, Kindorf No. D-990, or equal. Spot inserts shall be Super Strut No. 452, Kindorf No. D-255, or equal.
- F. Threaded anchors for use in concrete shall be self-drilling type expansion anchors made of case hardened and drawn carburized steel. The anchors and expander plugs shall be furnished with a rustproof finish. The expansion anchors shall be concrete fasteners as manufactured by the ITW "Red Head", Ideal Industries Co., or equal.
- G. Threaded anchors for heavy loads (i.e.: panels, transformers, disconnect switches) supported from masonry or precast concrete panels shall be epoxy based adhesive anchors with threaded rod and screen tube. Adhesives shall match the application, as recommended by the anchor manufacturer. Threaded rods, nuts, and washers shall be furnished with a rustproof finish. Adhesive anchors shall be Hilti Type HIT or equal.
- H. Anchors for light loads (i.e.: conduit clamps, outlet boxes, small pull and junction boxes) supported from masonry or precast concrete panels shall be lead type or plastic expansion anchors with corrosion resistant screws.
- I. Threaded rods, nuts, washers, screws, and bolts for anchors used in areas classified as hazardous and in corrosive areas shall be made of 316 stainless steel. Also expansion anchors for light loads used in masonry or precast concrete panels in these areas shall be plastic only.
- J. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions. Tighten all bolted connections to manufacturer's recommended torque values with compensation for lubricated threads (anti-seize, lubricating and protective compound applied) to avoid over-torquing.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not anchor supports from pipes, ducts, mechanical equipment, or conduit.
- D. Do not use spring steel clips and clamps.
- E. Obtain permission from Engineer before using powder-actuated anchors.
- F. Obtain permission from Engineer before drilling or cutting structural members.
- G. Fabricate supports from structural steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- H. Field Cutting: Cut edges of strut and hanger rod shall have corners rounded, edges beveled and burrs removed. If field cutting the strut is required, only clean, sharp, dedicated tools shall be used. Oil, shavings and other residue of cuttings shall be removed prior to installation.
- I. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- J. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
- K. All electrical enclosures, including raceways, boxes, panelboards, motor control equipment, etc., shall be securely attached to the building or structure walls by means of concrete inserts or expansion anchors, unless indicated as rack mounted on the Drawings or of free standing design. Unless otherwise indicated, all electrical enclosures, except conduit and outlet boxes,

shall be spaced at least 1/2 inch from the wall or ceiling with Unistrut, Grinnell "Power-Strut", or equal.

- L. The use of wood plugs for anchoring raceways, cabinets, enclosures, or equipment to concrete or masonry will not be permitted.
- M. Contractor shall provide and install, where required, the additional steel to adequately support all conduits, boxes, and all other electrical equipment.
- N. Wires and cables shall be laced when entering or leaving pull or junction boxes and at each termination. Wires and cables shall be laced so that the wires of the individual circuits are laced together by circuit. All wiring entering and exiting electrical enclosures shall be bundled into groups. Power, lighting, control, alarm, annunciator, and instrumentation wiring shall be bundled and laced as specified herein.
- O. The threads of all corrosive area, hazardous area, outdoor, and below grade support connections shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- P. Metallic, except stainless steel, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum 0.040-inch (40 mil) thickness as specified under 26 05 33.23 - Surface Raceways for Electrical Systems. Where factory PVC coating is not available, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

END OF SECTION

SECTION 26 05 33.13 UNDERGROUND CONDUIT SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals to provide direct buried conduit as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 33.23 - Surface Raceways for Electrical Systems

1.03 REFERENCE STAND

- A. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- E. ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality
- F. IEEE C2 - National Electrical Safety Code
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
- J. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations
- K. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
- L. NEMA TC 10 - PVC and ABS Plastic Communications Duct and Fittings for Underground Installation
- M. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series
- N. NFPA 70 - National Electrical Code (NEC)
- O. UL 6 - UL Standard for Safety Electrical Rigid Metal Conduit – Steel

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes and handholes.
 - 2. Indicate dimensions, reinforcement, size, and routings of underground ducts and duct banks.
- B. Product Data:

1. Provide for metallic conduit; non-metallic duct, conduit, and duct fittings; manhole and handhole accessories, frames, and covers.
- C. Manufacturer's Instructions:
 1. Include instructions for storage, handling, protection, examination, preparation, and installation.
- D. Project Record Documents:
 1. Accurately record actual locations of each manhole and handhole.

1.05 REGULATORY REQUIREMENTS

- A. Provide Products listed and classified by Underwriters Laboratories, Inc., or other testing firm acceptable to the authority having jurisdiction, as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 60 00 - Product Requirements.
- B. Accept conduit on site.
- C. Inspect for damage.
- D. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.07 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on the Contract Drawings.
- B. Verify routing and termination locations of underground conduits prior to excavation for rough-in.

PART 2 PRODUCTS

2.01 RIGID ALUMINUM CONDUIT

- A. Manufacturers: As specified under Section 26 05 33.23 - Surface Raceways for Electrical Systems.
- B. Rigid Steel Conduit: ANSI C80.5, UL6.
- C. Fittings: ANSI/NEMA FB 1; UL Standard 514B; steel.

2.02 NON-METALLIC CONDUIT

- A. Manufacturers:
 1. Carlon
 2. JM Eagle
 3. Osburn Associates, Inc.
 4. Scepter
 5. Cantex
- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3. Fittings and adapters shall be as supplied by the conduit manufacturer.

2.03 NON-METALLIC, PVC DUCT

- A. Manufacturers:

1. JM Eagle
 2. Robintech
 3. Osburn Associates, Inc.
- B. Plastic Utilities Duct: NEMA TC 8; PVC, Type EB or DB.
 - C. Plastic Utility Duct Fittings: NEMA TC 9.
 - D. Plastic Communications Duct and Fittings: NEMA TC 10, Type EB or DB.
 - E. Fittings and adapters shall be as supplied by the duct manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavation, base material installation, and compaction is completed.

3.02 DIRECT BURIED CONDUIT INSTALLATION

- A. Underground conduits for direct burial shall be rigid aluminum conduit or non-metallic conduit.
- B. Install rigid steel conduit according to NECA 101-2006.
- C. Plastic fittings shall be of the type recommended for the type of conduit used. Conduits shall be coupled together to make a water-tight connection.
- D. Install non-metallic conduit in accordance with manufacturer's instructions.
- E. Join non-metallic conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full, even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum. Contractor shall allow 24 hours, minimum, for solvents to evaporate after cementing the last joint in the raceway system before pulling in any wires or cables.
- F. Direct buried conduits shall be installed 30 inches (minimum) below grade (unless otherwise shown on Drawings) and shall slope (minimum 3 inches per 100 feet) to handholes, manholes, cable vaults, or other structures.
- G. Changes in conduit elevation such as ells, stubs, bends, etc., shall be galvanized rigid steel. Conduit risers above grade shall be rigid steel. Conduits shall be rigid steel within 10'-0" of structures. Conduits under buildings shall be rigid steel.
- H. Provide suitable fish line in each spare or empty duct, except sleeves and nipples.
- I. Excavate and backfill trenches in accordance with other Sections of the Specifications, or in accordance with the Contract Drawings. Install warning tape above duct runs, as indicated on the Contract Drawings.

END OF SECTION

SECTION 26 05 33.16

BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to provide wall and ceiling outlet boxes, pull and junctions boxes, and wireways as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33.13 - Underground Conduit Systems
- E. Section 26 05 33.23 - Surface Raceways for Electrical Systems
- F. Section 26 05 53 - Electrical Identification
- G. Section 26 27 16 - Cabinets and Enclosures
- H. Section 26 27 26 - Wiring Devices

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical
- B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
- C. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- F. NFPA 70 - National Electrical Code

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate materials, finishes, dimensions, listings, and standards compliance.
- B. Product Data:
 - 1. Provide data for boxes, wireways, and accessories.
- C. Manufacturer's Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. Project Record Documents: The following documentation shall be provided in accordance with Section 01 77 00 - Closeout Procedures:
 - 1. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.05 REGULATORY REQUIREMENTS

- A. Provide Products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to the authority having jurisdiction, as suitable for the purpose specified and indicated.

- B. Boxes shall be sized per Article 314 of the National Electrical Code as a minimum.

PART 2 PRODUCTS

2.01 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- B. Non-metallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 16 - Cabinets and Enclosures 2.
- E. Covers for boxes containing wiring devices shall be as specified in Section 26 27 16 - Cabinets and Enclosures.
- F. Outlet boxes for pendant mounted lighting fixtures shall be ball mount, GS or AL Series as manufactured by Appleton Electric Co. or equal. Outlet boxes for pendant mounted fixtures in hazardous areas shall be similar, except explosion proof, Appleton Electric Co. EFHU or equal.
- G. Outlet boxes in hazardous locations shall be explosion proof, Class I, Division 1, Group D, PVC Coated with a minimum thickness of 0.040", and shall be Type FS, FD, or GUA, and as manufactured by Plasti-Bond, Perma-Cote, Calbond, or equal and shall be Type GUA, GUF, and GUJ as manufactured by Crouse-Hinds Co., Appleton, or equal.

2.02 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 27 16
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Pull and junction boxes for hazardous areas shall be cast iron alloy, explosion proof, Class I, Division 1, Group D as manufactured by Curlee, Appleton, or equal, except boxes for intrinsically safe circuits may be NEMA Type 4 or non-metallic NEMA Type 4X rated.
- E. Single and two gang pull boxes and junction boxes shall be rust proof, cast metal, Type FD boxes with gasketed covers.
- F. Larger boxes and raceways shall be NEMA Type 4X with stainless steel hardware in all other locations or where indicated on the Drawings, built of Code gauge steel, with angle iron supports and braces. Cable support racks shall be provided where required. Access shall be by means of removable, gasketed screw covers fastened with machine screws.
- G. NEMA Type 4X boxes shall be of corrosion resistant, 304 stainless steel suitable for surface mounting. Barriers shall be provided where indicated on the Drawings or required.
- H. All pull boxes installed below grade within the structures shall be provided with a drain, Crouse-Hinds ECD Universal Series, Appleton, or equal mounted on a bolt-on, gasketed hub or Stahlin Drain Vent on NEMA Type 4X boxes.
- I. In-line pull boxes, where shown on the Drawings, shall be Appleton Type PTC with solid gasket or equal.

- J. Threaded conduit fittings with gasketed covers shall be used for exposed conduit outlets and boxes.
- K. Conduit bodies and fittings shall be of cast iron, malleable iron, and/or galvanized steel.

2.03 WIREWAYS

- A. Wiring ducts shall be NEMA 4X in corrosive locations; or stainless steel, where indicated on the Drawings. Metallic wireways shall be 14-gauge steel raceways and all wireways shall be provided with removable covers held with captive screws. Fittings shall be designed to be used with the ducts to result in an unobstructed system. The ducts and fittings shall be sized as shown on the Drawings. Hardware on stainless steel and non-metallic wiring ducts shall be made of stainless steel.
- B. The wiring ducts shall be as manufactured by Keystone, Hoffman Engineering Co., B-Line, or equal.

2.04 MISCELLANEOUS COMPONENTS

- A. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify locations of floor boxes and outlets in all work areas prior to rough-in.

3.02 INSTALLATION

- A. Install boxes in accordance with NECA "Standard of Installation."
- B. Install pull boxes and junction boxes in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Pull boxes and/or junction boxes shall be used in any conduit run where a splice is required. Pull boxes shall be provided every 200 feet of straight run, every 150 feet after 90 degrees of bends, every 100 feet after 180 degrees of bends, and every 50 feet after 270 degrees of bends. More than 270 degrees worth of bends shall not be installed between pulling points in any conduit run.
- D. Pull boxes, auxiliary pull fittings (slip joints), and cable raceways for the pulling, nesting, or concealment of wires or cables shall be provided where indicated on the Drawings and also where required, though not indicated, as specified above.
- E. Mark or label all boxes as specified in Section 26 05 53 - Electrical Identification.
- F. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- G. Enough room shall be supplied in boxes for insulating joints, wires, and bushings, and deep boxes shall be installed where required by the type of fixture or outlet called for on the Drawings.
- H. Wire and cable splices and tap connections shall be made in junction boxes only; conduit type fittings shall not be used as junction boxes.
- I. Electrical boxes are shown on Drawings in approximate locations, unless dimensioned. Adjust box location up to 8 feet, if required to accommodate intended purpose.
- J. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 16 - Cabinets and Enclosures.
- K. Maintain headroom and present neat mechanical appearance.

- L. Install boxes to preserve fire resistance rating of partitions and other elements.
- M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- N. Use flush mounting outlet box in finished areas.
- O. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- P. At each concealed outlet in slabs or walls in dry locations only, a galvanized, pressed steel box of the knockout type, of not less than No. 12 B & S gauge, shall be placed and securely fastened. The conduits shall be fastened to these boxes with lock nuts, inside and outside, and bushings. Unused knockouts or holes must be left sealed.
- Q. Support boxes independently of conduit.
- R. Use gang box where more than one device is mounted together. Do not use sectional box.
- S. Use cast outlet box in exterior locations and wet locations.
- T. Set floor boxes level.
- U. Wall and ceiling mounted pull and junction boxes shall be spaced 1/2-inch minimum out from the wall or ceiling using corrosion resistant channel: Unistrut; Grinnell "Power-Strut", or other approved corrosion resistant spacers.
- V. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- W. The threads of all corrosive area, hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, pull and junction box covers, lighting fixture reflector, guard, and outlet box connections, wiring device boxes, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- X. Metallic, except stainless steel, pull boxes, junction boxes, outlet boxes, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum 0.040-inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

3.03 ADJUSTING AND CLEANING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.
- C. Clean interior of boxes to remove dust, debris, and other material.
- D. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 33.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to provide the following items, as shown on the Drawings:
 - 1. Metal conduit.
 - 2. Flexible metal conduit.
 - 3. Liquidtight flexible metal conduit.
 - 4. Non-metallic conduit.
 - 5. Flexible non-metallic conduit.
 - 6. Fittings and conduit bodies.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33.13 - Underground Conduit Systems
- E. Section 26 05 33.16 - Boxes for Electrical Systems
- F. Section 26 05 53 - Electrical Identification
- G. Section 26 07 00 - Wire and Cable
- H. Section 26 07 05 - Electrical Testing and Equipment

1.03 REFERENCE STANDARDS

- A. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A)
- B. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT)
- C. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
- E. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit
- F. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
- G. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
- H. NFPA 70 - National Electrical Code
- I. UL 6 - Electrical Rigid Metal Conduit-Steel

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate materials, finishes, dimensions, listings, and standards compliance.
- B. Product Data:

1. Provide data for boxes, wireways, and accessories.
- C. Manufacturer's Instructions:
 1. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. Project Record Documents: The following documentation shall be provided in accordance with Section 01 77 00 - Closeout Procedures:
 1. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 60 00 - Product Requirements.
- B. Accept materials on site and inspect for damage.
- C. Conduit shall be delivered at the construction site in not less than ten-foot lengths; each length of conduit to have approval label of the Underwriters.
- D. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- E. Protect PVC conduit from sunlight.

1.06 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations, unless dimensioned. Route as required to complete the raceway system.

PART 2 PRODUCTS

2.01 CONDUIT AND FITTINGS

- A. Provide conduit, conduit fittings, outlet boxes, pull boxes, supports, hangers, plates, and such other items as are incidental to or required for a complete installation, which shall be made of cast aluminum unless indicated otherwise.
- B. No threadless couplings or running threads will be permitted on rigid conduits.
- C. No conduit smaller than 3/4-inch shall be used, unless otherwise indicated or specified.
- D. raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved.
- E. Wherever conduits cross building, tank, or other structural expansion joints, Contractor shall provide and install conduit expansion/deflection fittings as manufactured by O.Z./Gedney Type DX, Crouse-Hinds, Thomas & Betts, or equal, unless indicated on the Drawings as requiring an expansion fitting.
- F. Expansion fittings with copper, ground bonding jumpers shall be installed where indicated on the Drawings and shall be O.Z./Gedney Type AX with Type BJ bonding jumper, Crouse-Hinds, or equal.

2.02 RIGID METAL CONDUIT

- A. Rigid aluminum conduits shall be manufactured of 6063 alloy, temper T-1, and especially selected with reference to uniformity of thickness and free from defects.

- B. Manufacturers:
 - 1. V.A.W. of America, Inc.
 - 2. Alcoa
 - 3. Engineer-approved equal
- C. Rigid Aluminum Conduit: ANSI C80.5, UL 6.

2.03 PVC COATED METAL CONDUIT AND FITTINGS

- A. Manufacturers:
 - 1. Thomas & Betts Ocal Blue
 - 2. Robroy Industries Plasti-Bond Red H₂OT
- B. Description: NEMA RN 1; rigid aluminum conduit with external PVC coating, 40-mil thick. UL listed with the PVC coating as the primary corrosion protection.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; aluminum fittings with external PVC coating to match conduit. UL listed with the PVC coating as the primary corrosion protection.
- D. PVC coated conduit, fittings, and fasteners shall be supplied from the same manufacturer.
- E. PVC coated conduit shall be rigid metal conduit factory encased with polyvinyl chloride of 0.040-inch (40 mil) thickness minimum on the exterior and a urethane coating of 0.002-inch (2 mil) thickness nominal or a phenolic coating of 0.003-inch (3 mil) thickness nominal on the interior. The adhesion of the coating shall be greater than the tensile strength of the coating (NEMA RN1 requires a minimum tensile strength of 2000 psi for PVC).
- F. Fittings and fasteners shall have the same PVC coating on the exterior as the conduit. Hollow fittings shall also have the same interior coating as the conduit. Couplings, fittings, and conduit bodies shall have PVC sleeves at threaded joints with length equal to the outside diameter of the associated conduit or 2 inches. Conduit body covers shall be provided with stainless steel screws with PVC coated, hex heads.

2.04 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. AFC
 - 2. Southwire - Alflex
- B. Description: Interlocked aluminum construction.
- C. Fittings: ANSI/NEMA FB 1.
- D. Flexible metallic conduit shall be 3/4-inch nominal trade size (minimum) flexible aluminum conduit tubing, meeting Underwriters' Laboratories Standard for flexible steel conduit (UL 1).

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anaconda
 - 2. Electriflex
 - 3. AFC
 - 4. Thomas & Betts Corp.
- B. Description: Interlocked aluminum construction with PVC jacket.
- C. Fittings: ANSI/NEMA FB 1.

- D. Fittings used with this conduit shall be of the liquid tight type and shall be equipped with approved type grounding devices to ensure continuity between the conduit and the connection. The fittings shall seal out vapors, coolants, oil, water, dust, and other foreign matter and shall be installed with a sealing O-ring between the fitting and the box. The fittings shall be "ST" series connections as manufactured by Appleton Electric Co., Ideal Industries 75-000 Series, or equal.

2.06 NON-METALLIC, PVC CONDUIT

- A. Manufacturers:
 - 1. Thomas & Betts – Carlon
 - 2. JM Eagle
 - 3. Osburn Associates, Inc.
 - 4. IPEX - Scepter
 - 5. Cantex
- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.
- D. Plastic (PVC) conduit shall be heavy wall, Schedule 40 with integral bell, polyvinyl chloride (PVC), non-metallic conduit.

2.07 RIGID STEEL CONDUIT

- A. Rigid steel conduits shall consist of heavy wall, mild steel tube, hot-dipped galvanized with threads electrogalvanized after cutting, and especially selected with reference to uniformity of thickness and freedom from defects. Fittings shall be suitable and approved for use in rigid steel conduit systems.
- B. Rigid galvanized conduit shall be used if conduit is installed in concrete floor or walls.
- C. Manufacturers:
 - 1. Wheatland Tube Company
 - 2. Allied Tube & Conduit Corporation
 - 3. Maverick Pipe
 - 4. Approved Equal
- D. Rigid Steel Conduit: ANSI C80.1, UL 6.
- E. Fittings and Conduit Bodies: ANSI/NEMA FB 1; UL 514B; all steel fittings.

2.08 MISCELLANEOUS FITTINGS AND MATERIALS

- A. Insulated grounding bushings shall be Type HBLG as manufactured by O.Z./Gedney, American Fittings Corp., Thomas & Betts, or equal.
- B. Insulating bushings shall be high impact resistant, thermoset plastic, 150°C rated, Type A as manufactured by O.Z./Gedney, American Fittings Corp., Thomas & Betts, or equal.
- C. Locknuts shall be of the sealing type, O.Z./Gedney Type SLG, Appleton, American Fittings Corp., Thomas & Betts, or equal.
- D. Liquidtight hubs shall have a sealing ring between the fitting and the box and an insulated throat to ensure protection of the wires as pulled. Hubs shall be made of aluminum, UL listed, and shall meet or exceed the requirements of UL test 514B. Liquidtight hubs shall be Bridgeport, O.Z./Gedney Type CHM, Ideal Industries 75-000 Series, American Fittings Corp., Thomas & Betts, or equal.

- E. Sealing fittings shall be Crouse-Hinds Co. Type EYS, Appleton, or equal. Sealing fittings used as water stops shall have an integral drain and shall be Crouse-Hinds Type EYD, Appleton, Thomas & Betts, or equal. Sealing fittings in hazardous or corrosive areas shall be PVC coated.
- F. Conduit sealing compound shall be Waterguard Desiccants Industrial Encapsulant, Polywater FST-250, or equal.
- G. Link seal for sealing conduits into sleeves and cored openings shall be GPT Industries - Thunderline, Metraflex Co. Metraseal, Calpico, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install conduit in accordance with NECA 101-2013, Aluminum Conduits (Rigid, IMC, EMT).
- B. Arrange supports to prevent misalignment during wiring installation.
- C. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- D. Do not attach conduit to ceiling support wires.
- E. Arrange conduit to maintain headroom and present neat appearance.
- F. Identify raceway systems under provisions of Section 26 05 53 - Electrical Identification.
- G. Joints shall be made tight with standard couplings and corners turned with elbows or long radius bends in pipe.
- H. Exposed multiple runs of conduit indoors shall be supported on hangers suspended from concrete inserts or structural steel. Single runs of conduit may be attached to ceilings or walls by means of approved type anchors. Conduit and other equipment may be attached to structural steel only where approved by Owner. Conduit shall be secured to the supports by means of galvanized malleable iron clamps using two bolts or machine screws. Conduit supports, hangers, and anchors shall be as specified under Section 26 05 29 - Hangers and Supports for Electrical Systems.
- I. The use of wood plugs for anchoring raceways to concrete or masonry will not be permitted.
- J. Conduits installed exposed shall be run vertically or horizontally and shall be parallel or at right angles to the building or structure walls.
- K. Contractor shall provide and install, where required, the additional steel to adequately support conduits, boxes, and other electrical equipment.
- L. Conduit shall be dry, clean, and free of obstructions before conductors are pulled in. If there is evidence of moisture, obstructions, or foreign matter in the conduit when the conductors are installed, the wiring shall be removed, and the conduit cleaned to the satisfaction of Owner. Wiring showing evidence of damaged insulation shall be replaced.
- M. Concealed conduit shall be placed in floors, ceilings, and walls before concrete is poured and in masonry walls as the walls are laid up. The conduit shall be blocked and fastened in place to prevent any displacement during construction. Conduits shall be separated by at least one conduit diameter, unless specifically authorized by Owner to do otherwise. Conduit joints shall be made tight with galvanized couplings or approved unions.
- N. Steel conduit run exposed shall be supported at intervals not exceeding 8 feet, unless shown otherwise on the Drawings. Multiple runs of conduit shall be mounted with steel supports so arranged that each individual conduit is clamped in place.
- O. Conduit installed on walls shall be mounted on spacers to provide not less than 1/4-inch space between the conduit and the wall.

- P. Conduit installed exposed outdoors shall be supported by structural steel members.
- Q. Conduit entrances through below grade walls and poured-in-place concrete roofs shall be installed through sleeves poured in place or through core drilled opening, unless poured in place.
- R. Sleeves for passage of conduits through poured concrete roofs and below grade walls shall be constructed of heavy wall steel pipe with full circle continuously welded water stop plate. Sleeves shall be sized to accommodate the conduit and link seal combination as specified hereinbefore.
- S. Conduits passing through openings or sleeves in roofs, below grade walls, or floors shall be sealed in place and made watertight with link seal.
- T. Conduit stubs for future use shall be terminated with pipe caps.
- U. Conduit runs installed horizontally overhead shall allow a minimum of 7 feet of headroom, except where installed along structures, piping, equipment, or in other areas where headroom cannot be maintained because of other considerations.
- V. Wherever a conduit emerges from the underside of a slab or roof or enters an area from above and that slab or area or conduit is exposed to the weather, then that conduit shall be provided with a pull box or fitting and filled to a length of 12 inches minimum with conduit sealing compound where the conduit emerges indoors to prevent water from following the conduit interior. The sealing compound shall be as specified hereinbefore under Miscellaneous Fittings and Materials.
- W. Wherever a conduit enters an electrical equipment enclosure from an underground or outdoor location and other locations where indicated on the Drawings, the conduit opening shall be sealed after the wires and/or cables are pulled. One and one half (1½) inch and smaller conduits with more than 20 percent wire fill may be sealed with conduit sealing compound; other conduits, where required, shall be provided with conduit sealing bushings or compound bushings with ground conductor connectors, as manufactured by O.Z./Gedney or equal. Conduit sealing compound shall be forced into conduits to a minimum depth of 12 inches.
- X. Field bends in conduit shall not be of a lesser radius than that of manufactured elbows of the same trade size and shall show no flattening of the conduit. Conduit bends shall be held to as large a radius as possible for ease in pulling of conductors and to provide a neatly installed appearance. Generally, conduits 1-inch and smaller shall be bent in the field.
- Y. Other conduit bends shall conform to the following: 2-inch and 2-1/2-inch conduit, 24-inch radius, 3-inch and larger with a minimum radius of 36 inches. Except where conduit runs are shown in exact detail on Drawings, the maximum length of straight conduit runs shall be 200 feet between pull boxes, with 50 feet deducted for each 90-degree bend and 25 feet deducted for each 45 degree bend, reduction in length for other angle bends shall be figured on a similar basis.
- Z. Conduit parallel to or crossing uninsulated hot water or steam pipes shall be separated from same by 12 inches, if parallel, or 7 inches if crossing. Where hot water or steam pipe lines are insulated, conduit shall clear the insulation surface by 2 inches. Conduit shall not run directly under cold water lines.
- AA. Conduit stub-ups into the bottom of NEMA Type 12, floor mounted enclosures, including motor control centers, shall enter the enclosure through individual holes in the bottom plate or sheet steel bottom and the openings shall be sealed around each conduit to maintain the enclosure's NEMA Type 12 rating.
- BB. Conduits and sleeves passing through openings in walls above grade or floors shall be sealed in place and made watertight with non-shrink grout or other Owner approved sealant. Non-shrink grout used in floor or wall openings, shall be of the non-metallic type. Openings in fire rated walls and floors shall also be sealed with a fire barrier sealing system capable of maintaining the designed fire rating of the wall or floor and suitable for sealing out smoke and

fumes. The fire barrier sealing system shall be capable of passing the ASTM E-814 (UL 1479) fire test and shall be subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory; provide products by Hilti Construction Chemicals, Inc.; 3M Fire Protection Products; or equal.

- CC. Openings in boxouts through floors or walls or in the bottom of electrical equipment shall be closed using split insulating blocks or non-shrink grout in a manner as approved by OWNER. Unused sleeves shall be capped or plugged at both ends with approved fittings.
- DD. Metallic sleeves containing a ground conductor shall be bonded at each end to the ground conductor.
- EE. The ends of metallic conduits or elbows shall be cut square, reamed and threaded.
- FF. The threads of steel conduit connections concealed in concrete shall be coated at the time of installation with No. B69A45 Zinc clad primary coating, as manufactured by Sherwin William's Corp., Ideal Industries No. 40-630, CRC Chemicals Zinc-It, or equal.
- GG. The threads (metallic) of corrosive area, outdoor, below grade, and hazardous area equipment connections including conduit, conduit fittings, pull and junction box covers, lighting fixture reflector, guard, and outlet box connections, wiring device boxes, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly. Coating compound shall be NO-OX-ID "A Special" by Sanchem, Inc., Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, or equal.
- HH. Ground and bond metallic raceway systems under provisions of Section 26 0526, Grounding and Bonding.
 - II. Metallic conduits, except those terminated in metal boxes or enclosures without knockouts and secured with double locknuts, integral hubs, or liquid-tight hubs, shall be terminated with insulated grounding bushings. Conduits terminated in metal boxes or enclosures without knockouts and secured with double locknuts shall be terminated with an insulating bushing.
 - JJ. Conduits and sleeves, metallic and non-metallic, intended for the passage of wire or cable and not terminated with a fitting, shall be terminated with a bushing or end bell.
 - KK. Connections between metallic conduits and NEMA Type 1 or NEMA Type 12 steel boxes shall be made with double locknuts. Connections between conduits and NEMA Type 3, 3R, 4, and 4X boxes shall be made with watertight connections. Watertight connections shall consist of integral hubs or liquid-tight hubs.
 - LL. Sealing fittings and other fittings for conduit in hazardous locations shall be explosion proof, Class I, Division 1, Group D.
 - MM. Electrical metal tubing or so called "Thin Wall" conduit and fittings shall not be used.
 - NN. Raceway systems, in general, shall consist of Rigid Metal Conduit and fittings or non-metallic, FRP Conduit and fittings.
 - OO. Conduit and fittings in areas classified as corrosive, hazardous, and other areas indicated on the Drawings, shall be PVC coated metal conduit and fittings, unless constructed of stainless steel. The installation of such conduit and fittings shall be in strict accordance with the manufacturer's printed instructions and using the manufacturer's recommended tools and touch-up procedures.
 - PP. To guarantee proper installation procedures and ensure the validation of the manufacturer's warranty, Contractor must request installation training from the manufacturer, or manufacturer's appointed representative, prior to installing PVC coated conduit and fittings on the project.
 - 1. The manufacturer shall provide installation training at no cost to Contractor.
 - 2. Contractor shall provide the time and place, preferably at the job site, and the manufacturer shall certify every Contractor's employee completing the installation training.

- QQ. Metallic conduit, conduit fittings, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum 0.040-inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.
- RR. Flexible conduit may be used only where rigid conduit is impracticable or where indicated on the Drawings.
- SS. Liquid-tight, PVC coated, flexible metal conduit and associated fittings shall be installed as follows:
1. Sections of flexible conduit larger than 1-1/4 inches in diameter shall be paralleled with a braided copper bonding strap connected between the last section of rigid conduit and the frame of the equipment to ensure a continuous ground.
 2. Liquid-tight, PVC coated, flexible metal conduit shall be installed with watertight connectors and in minimum lengths without sharp bends.
- TT. Final conduit connections to motors and other machinery, equipment, and devices which may be subject to movement or vibration shall be made with 15 to 18 inches of flexible, liquid-tight, metallic conduit.
- UU. Final conduit connections to motors and other machinery, equipment and devices in hazardous areas which may be subject to movement or vibration shall be made with explosion proof, Class I, Division 1, Group D, flexible conduit couplings.
- VV. Flexible metallic conduit may be used for final connections to lay-in fluorescent lighting fixtures.
- WW. Plastic (PVC) conduit may be used only where indicated on the Drawings.
- XX. Install non-metallic conduit in accordance with manufacturer's instructions.
- YY. Join non-metallic, PVC conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum. Contractor shall allow 24 hours, minimum, for solvents to evaporate after cementing the last joint in the raceway system before pulling in any wires or cables.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide nameplates and labels, wire and cable markers, conduit markers and other identification for all electrical apparatus as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09 96 00 - Industrial Paints and Coatings

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electric Code (NEC)

1.04 SUBMITTALS

- A. Shop Drawings: The complete description and enumeration of proposed electrical-identification-nomenclature text and electrical-identification devices shall be shown on the Shop Drawings for the associated equipment or systems.
- B. Product Data: Manufacturer's cut sheets, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
- C. Samples:
 - 1. Nameplates: Samples of nameplates shall be submitted for the Engineer's selection of size and lettering style.
 - 2. Wire Labels: Samples of wire and cable labels shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.
- D. Commissioning Documents: Point-to-point wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.

PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. The nameplates shall be 1-1/4-inch high by 3-1/2-inch wide (minimum), except pushbutton and selector switch stations and other enclosures where space is limited may have smaller plates of suitable size and shall be attached to the equipment by means of corrosion resistant screws. Nameplates may be attached to equipment located in dry, interior areas by means of pressure sensitive, firm acrylic adhesive tape, 3M "Scotch" No. 468 or equal. The plates shall be white laminated plastic with engraved black letters approximately 3/32-inch thick with beveled edges. Engraved letters shall be 1/8-inch high (minimum), block type.
- B. Circuit number markers shall consist of self-adhesive vinyl cloth or polyvinyl fluoride film markers with 1/8-inch high (minimum), black lettering on a yellow background, W. H. Brady Co. 3410 Series, Ideal Industries 44-500 Series and 44-600 Series, or equal. Circuit number markers may also consist of computer or typewriter generated, vinyl cloth, permanent, non-smearing, self-adhesive markers such as Brady Datab, BradyMarker XC Plus, 3M Scotchcode SCS or STS, or equal. Circuit number markers for panelboard circuit breakers may be the manufacturer's standard.

- C. Arc flash and shock hazard warning labels shall consist of self-adhesive vinyl or polyester signs, 3-1/2" by 5" minimum, with "WARNING" header (black letters on orange field), "Arc Flash and Shock Hazard" subheader and write-in spaces for the following information:
1. ____ Flash Hazard Boundary
 2. ____ cal/cm² Flash Hazard at 18 inches
 3. ____ PPE _____
 4. ____ Shock Hazard When Cover is _____
 5. ____ Limited Approach
 6. ____ Restricted Approach _____
 7. Equipment Name: _____
- D. Warning labels shall be in compliance with NEC 110.16 requirements. Warning labels shall be Brady Signmark No. 89220, Lab Safety Supply Co. No. 68691, Seton Style No. M0548, or equal.

2.02 WIRE MARKERS

- A. Wire and cable tags for use in large pull boxes, large junction boxes shall be made of 1/8-inch (minimum) thick white laminated plastic, 1-1/4-inches by 3-1/2-inches, with black engraved identification in letters 3/64-inch deep by 3/16-inch high (minimum). Tags shall be drilled at each end and secured twice to each cable by 3/32-inch (minimum) diameter polyethylene cord. Tags shall be engraved with the circuit number, equipment served, and associated nominal voltage level.
- B. Wire and cable number tags for use in pull or junction boxes and at termination points shall be computer or typewriter generated, vinyl cloth, permanent, non-smearing, self-adhesive markers such as Brady Datab, Brady Marker XC Plus, or 3M Scotchcode. Pre-printed, vinyl cloth, plastic coated, self-adhesive, tape markers as manufactured by W. H. Brady Co. or 3M Company shall also be acceptable.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive nameplates and labels.

3.02 INSTALLATION

- A. Nameplates shall be installed on the doors or covers of all panels, panelboards, starters, contactors, transfer switches, relays, control devices, signaling devices, and all other electrical equipment furnished under this Contract, except remote mounted pushbutton and selector switch stations, mounted adjacent to identified and associated disconnect switches or other control devices, need not be identified as described herein.
- B. Nameplate engraving for equipment and devices associated with motor control center, motor starters, panelboard, or control panel circuits shall match the engraving indicated in schedules on the Drawings, except nameplates for spare units and devices shall be furnished blank. Other nameplates shall be engraved as follows and shall be included on nameplate schedules submitted to the Owner for approval:
1. First Line: Process description, equipment served, or area served (if applicable).
 2. Second Line: Equipment or device description.
 3. Third Line: Equipment or device designation number and power source circuit number.
 4. Abbreviations shall be used only where full wording will not fit. See the Drawings for nameplate details.

- C. Devices and equipment powered from lighting panelboards shall be marked with the appropriate circuit number(s). Lighting circuits shall be identified on switch cover plates, receptacles on cover plates, and other devices on enclosure door or on associated disconnect switch door or cover.
- D. The entire raceway system for intrinsically safe circuits shall be labeled "Intrinsic Safety Wiring" per National Electrical Code Article 504.80(B).
- E. Pull boxes shall be marked with the type of system within them, i.e.: 480V power, alarm, 120V control, etc.
- F. Wires and cables within control panels, motor starters, motor control centers, terminal boxes, etc. shall be tagged at each termination.
- G. The wires and cables of each circuit in pull boxes and junction boxes larger than 12 inches by 12 inches by 8 inches shall be bundled together, neatly arranged, and clearly identified with a tag secured with polyethylene cabling twine indicating circuit number, equipment served, and nominal voltage level.
- H. A system shall be developed and submitted to prevent duplication of wire numbers for wiring external to equipment. Equipment numbers or designations may be used as prefixes. Interconnecting diagrams shall clearly show wire numbers, originating terminal numbers, and destination terminal numbers.
- I. Enclosures, panels, boxes, and devices containing electrical components and circuits with exposed, energized parts when the door is open, shall have an arc flash and shock hazard warning label affixed to the door. Label blank fields shall be filled in with permanent markers according to the results of the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses, in Section 26 07 05 - Electrical Testing and Equipment.
- J. Label or otherwise clearly identify all panelboard branch circuit breakers feeding emergency lighting and exit fixtures as required by National Electrical Code Article 700.12(E).

END OF SECTION

SECTION 26 07 00 WIRE AND CABLE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide the following as shown on the Drawings, specified or required:
 - 1. Building wire.
 - 2. Underground feeder and branch circuit wire
 - 3. VFD load wire
 - 4. Instrumentation cable
 - 5. Communications cables
 - 6. Wiring connectors and connections

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems
- C. Section 26 05 33.13 - Underground Conduit Systems
- D. Section 26 05 33.16 - Boxes for Electrical Systems
- E. Section 26 05 33.23 - Surface Raceways for Electrical Systems
- F. Section 26 05 53 - Electrical Identification

1.03 REFERENCE STANDARDS

- A. ANSI C33.80 - Standard for Safety Grounding & Bonding Equipment
- B. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation)
- C. NFPA 70 - National Electric Code (NEC)
- D. UL 44 - Thermoset-Insulated Wires and Cables
- E. UL 83 - Thermoplastic-Insulated Wires and Cables

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01 33 00 - Submittal Procedures.
- B. Product Data: Manufacturer's cut sheets, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
- C. Test Reports: Indicate procedures and values obtained.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

1.05 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on the Contract Drawings.
- B. Wire and cable routing shown on Drawings is approximate. Route wire and cable as required to meet Project Conditions.
- C. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

1.06 COORDINATION

- A. Determine required separation between cable and other work.
- B. Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.01 GENERAL

- A. Wires and cables shall be permanently identified, at intervals not exceeding 3 feet, indicating type, size, voltage rating, and manufacturer's name.
- B. Wires and cables shall be continuous and shall be delivered in reels or in coils. Reels and coils shall be plainly marked for complete identification, including the wire or cable size, the number of conductors, the type of wire or cable, length, weight, thickness and character of the insulation, and the name of the manufacturer.
- C. Coils and reels of wires or cables shall carry original date perforated inspection labels of the Underwriter's laboratories, Inc. showing the number of feet and type of wire contained.

2.02 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor: Annealed, uncoated copper. Conductors shall be stranded. ASTM designation B-3.
- C. Conductor Temperature Rating: 90 degrees Celsius in wet locations; 90 degrees Celsius in dry locations.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation: ANSI/NFPA 70, Type THWN; high temperature polyvinyl chloride with nylon jacket or Type XHHW-2, high temperature cross-linked polyethylene.
- F. Manufacturers:
 - 1. General Cable
 - 2. Southwire Corporation

2.03 UNDERGROUND FEEDER AND BRANCH-CIRCUIT WIRE

- A. Description: Single conductor, ANSI/NFPA 70, Type USE-2.
- B. Conductor: Annealed copper. Conductors shall be stranded. ASTM designation B-3.
- C. Conductor temperature rating: 90 degrees Celsius in wet locations; 90 degrees Celsius in dry locations.
- D. Insulation voltage rating: 600 volts.
- E. Insulation: Type RHW-2.
- F. Manufacturers:
 - 1. General Cable
 - 2. Southwire Corporation

2.04 VFD LOAD WIRE

- A. Description: Multi-conductor, ANSI/NFPA 70 Type XHHW-2 or Type RHW-2.
- B. Conductor: Annealed copper. All conductors shall be stranded. ASTM designation B-8, B-33, B-172 or B-174.
- C. Conductor temperature rating: 90oC in wet or dry locations; 130oC emergency overload rating.
- D. Insulation voltage rating: 2000 volts minimum.

- E. Insulation: Type XHHW-2 or Type RHW-2, Cross-linked Polyethylene (XLPE).
- F. Shield: Overall copper tape shield with suitable overlap to prevent separation during installation.
- G. Jacket: Sunlight resistant, black overall PVC in accordance with S-95-658/NEMA WC70.
- H. Installation: If unshielded cable is provided, input line reactors must be provided and installed in VFD.
- I. Manufacturers:
 - 1. Southwire Corp.
 - 2. Belden
 - 3. General Cable
 - 4. Okonite Okoguard-Okolon
 - 5. Prysmian Cables & Systems

2.05 INSTRUMENTATION CABLE

- A. Description:
 - 1. Single pair cable shall be a single twisted pair, No. 18 gauge, stranded conductors with shield, drain wire, and overall jacket.
 - 2. Multiple pair cable shall be two or more individual twisted pair, No. 18 gauge, stranded conductors, each pair with shield and drain wire, and an overall jacket.
 - 3. Three conductor cable shall be three No. 18 gauge, stranded conductors with shield, drain wire, and overall jacket.
- B. Underground and General Use Cables:
 - 1. Conductors: Tinned copper.
 - 2. Insulation voltage rating: 300 volts.
 - 3. Insulation material:
 - a. Single pair cable – polyethylene.
 - 4. Multiple pair cable – polyethylene or polypropylene.
 - a. Three conductor cable – polyethylene.
 - 5. Shield Material: 100 percent aluminum polyester.
 - 6. Drain Wire: Stranded, tinned copper.
 - 7. Jacket: Chrome vinyl (PVC).
 - 8. Riser and Plenum Use Cables: These cables shall be similar to the underground and general use cables specified above, except that the insulation and the overall jacket materials shall be either FEP or PVDF
- C. Manufacturers:
 - 1. Single Pair Cable:
 - a. Belden No. 8760
 - b. Southwire Corporation
 - c. General Cable/Carol Brand No. C2534
 - 2. Multiple Pair Cable:
 - a. Belden No. 9773 through No. 9777

- b. Southwire Corporation
 - c. General Cable/Carol Brand No. C6047-C6051
- 3. Three Conductor Cable:
 - a. Belden No. 8770.
 - b. Southwire Corporation
 - c. General Cable/Carol Brand No. C2535

2.06 COMMUNICATIONS CABLE

- A. Wire type communications cables shall meet all applicable standards of EIA/TIA, IEEE, and the NEC.
- B. Fiberoptic cable shall meet applicable standards of EIA/TIA-4292.AAAA-1989, IEEE, and the NEC.
- C. Riser and Plenum Use Cables: Cables shall be similar to underground and general use cables specified above, except that the insulation and the overall jacket materials shall be either FEP or PVDF.
- D. Manufacturers:
 - 1. RS-232/422, RS-485/DH-485, Ethernet (Category 5), DH+ (Twinaxial), Unshielded twisted pair (UTP), and telephone cables shall be as manufactured by: Belden; Alpha; or Manhattan.
 - 2. Fiber optic Cables shall be 62.5/125 micron, multi-mode, tight-buffered, breakout type rated for indoor/outdoor use, shall be as manufactured by Optical Cable Corp. Ultra-Fox B-Series, Siecor, or AT&T.

2.07 WIRING CONNECTORS AND ASSOCIATED MATERIALS

- A. Wiring connectors shall be 75 degrees Celsius rated and suitable for use on copper conductors.
- B. VFD Cable Fittings:
 - 1. Fittings for terminating at VFDs shall conform to NEMA Standards.
 - 2. VFD fittings shall be designed to provide termination of armor and shield, if provided.
 - 3. When installed, VFD fittings shall include set-screws to limit vibrational loosening.
 - 4. VFD fittings shall be suitable protected from corrosion and shall be UL listed for use in Type 3R enclosures.
 - 5. Fittings shall form a water-tight seal to the outer jacket of the cable.
- C. Cable or cord strain reliefs shall consist of stainless steel wire mesh with support bale. Strain reliefs shall be of the split rod type where required or indicated on the Drawings.
- D. Cable Pulling Lubricant:
 - 1. Lubricant shall be UL listed and approved for use on the cable jacket or insulation.
 - 2. Lubricant shall be polymer based and shall dry completely when exposed to air.
- E. Manufacturers:
 - 1. Solderless Pressure Connectors:
 - a. 3M Company Model Scotchlok
 - b. Thomas & Betts Model Sta-Kon
 - c. Burndy Model Insulug Type TN

2. Spring Wire Connectors:
 - a. 3M Company Model Scotchlok
 - b. Ideal Model Wing-Nut
3. Compression Connectors:
 - a. 3M Company Model Scotchlok
 - b. Thomas & Betts Model Color-Keyed
 - c. Burndy Model Hylug
4. Tap Connectors:
 - a. Thomas & Betts Model Color-Keyed
 - b. Burndy Model Crimpit
 - c. Anderson Model Crimptaps
5. Watertight, Twist-On Connectors:
 - a. 3M Company Direct Bury Splice Kits
 - b. King Innovation "DryConn"
 - c. Ideal Industries, Inc. Twister DB Plus
6. Watertight, Insulated Connector Blocks:
 - a. Utilco Type USPA-SS, Type PSA-SS, or Type PED-SS
 - b. IlSCO Type USPA-SS
7. Electrical Insulating Tape:
 - a. 3M Company "Scotch" No. 33+
 - b. Plymouth "Premium Black"
8. High Temperature Tape:
 - a. 3M Company "Scotch" No. 70
 - b. Plymouth "Plysil"
9. Fireproofing Tape:
 - a. 3M Company "Scotch" No. 77
 - b. Plymouth No. 50
10. Woven Fiberglass Tape:
 - a. 3M Company "Scotch" No. 69
 - b. Plymouth "Plyglas"
11. Color Coding Tape:
 - a. 3M Company "Scotch" No. 35
 - b. Plymouth "Slipknot" No. 45
12. Insulating and Watertight Sealing Materials:
 - a. 3M Company "Scotchcast" kits
 - b. Raychem WCS Series heat shrinkable sleeves
 - c. 3M Company 8400 Series cold shrink materials

- d. 3M Company "Scotchkote" sealant
- 13. Watertight Cord Grip Fittings:
 - a. Crouse-Hinds CGB-SG Series
 - b. Appleton Electric Co.
 - c. Thomas & Betts
- 14. Cable or Cord Strain Relief:
 - a. Hubbell-Kellems
 - b. Daniel Woodhead Co.
- 15. Cable Pulling Lubricant:
 - a. American Polywater "Dyna-Blue"
 - b. Ideal "Aqua Gel"
 - c. Minerallac "Golden Glide"
 - d. 3M Company "GEL"

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.02 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.03 WIRING METHODS

- A. Interior Locations:
 - 1. Wire for general power, light, and control shall be building wire, Type THWN or Type XHHW-2 insulation, in raceway or metal sheathed or metal clad cable, where indicated.
 - 2. Cables for instrumentation signals shall be single or multiple pair Instrumentation Cable.
 - 3. Wire for connections between Variable Frequency Controllers and associated motors shall be shielded and shall be VFD Load Wire.
- B. Exterior Locations:
 - 1. Wire and cable for general power, light, and control for use in raceways exterior to buildings and in underground raceways shall be Type XHHW-2 insulation, underground feeder and branch circuit wire.
 - 2. Cables for instrumentation signals shall be three or more pair Instrumentation Cable.
 - 3. Wire for connections between Variable Frequency Controllers and associated motors shall be shielded and shall be VFD Load Wire.
- C. Use wiring methods indicated on Drawings.
- D. Color Coding: The color schedule for the conductor insulation of wire and cable shall conform to the following:
 - 1. Three phase lighting and power, 208Y/120 VAC-Black, Red, Dark Blue, White or Gray, and Green ground.
 - 2. Three phase lighting and power, 120/240 VAC-Black, Red, Orange (high leg to ground), White or Gray, and Green ground.

3. Single phase lighting and power, 120/240 VAC-Black, Red, White or Gray, and Green ground.
 4. Three phase lighting and power, 480 VAC-Brown, Orange, Yellow, and Green ground.
 5. Three phase lighting and power, 480Y/277 VAC-Brown, Orange, Yellow, Gray, and Green ground.
 6. DC power – Red with White stripe (+) and Light Blue with White stripe (-).
 7. Single conductor control, AC voltage – Red.
 8. Multi-conductor control cables – ICEA Method 1.
 9. Alarm, annunciator, instrumentation, graphic, and telemetering (if not shielded), AC voltage – Pink.
 10. Alarm, annunciator, instrumentation, graphic, and telemetering (if not shielded), DC voltage – Light Blue.
 11. Intrinsically safe circuits – Purple.
 12. On wire sizes larger than Number 8 AWG and/or where authorized by the Owner, coding may be identified by taping with the appropriate colored self-adhesive vinyl color coding tape.
 13. Grounding conductors shall be continuous green or bare for systems.
 14. Neutral conductors shall be continuous white or gray for systems.
- E. The installation of intrinsically safe circuits shall meet requirements of the NEC.
- F. Wiring Connections:
1. Dry location splices and tap connections shall consist of compression connectors or tap connectors, taped to 150 percent of insulation rating of the conductors.
 2. Final connections to equipment wire leads for No. 8 AWG and smaller wire in dry locations only, except 480 volt motor leads, may be made with spring wire connectors.
 3. Wet and damp location splices and tap connections shall consist of compression connectors or tap connectors with insulating and watertight sealing materials; watertight, twist-on connectors for wire sizes up to three No. 10 AWG; or watertight, insulated connector blocks; providing watertight connections suitable for direct burial.
 4. Conductor terminations at screw terminals shall consist of solderless pressure connectors, except where conductor terminations are included with the equipment being connected.
 5. Insulation of connections in lighting fixture and high temperature equipment shall consist of silicone rubber type high temperature tape with a woven fiberglass tape over-wrap.
 6. Electrical insulating tape (plastic type) shall be used on splice and tap connections, unless wire manufacturer's recommendations require otherwise.

3.04 INSTALLATION

- A. Installation of communication cables shall meet the requirements of NECA/BICSI 568-2001, Telecommunications.
- B. Installation of fiber optic cables shall be per NECA/FOA 301-1997, Fiber Optic Cables, requirements.
- C. Wiring shall be run in rigid metal raceway systems, underground conduit systems, or non-metallic FRP conduit systems, unless noted otherwise.
- D. Install products in accordance with manufacturer's instructions.

- E. Minimum size of conductors shall be No. 12 AWG, unless specifically approved and/or shown otherwise on the Drawings.
- F. Use stranded conductors for control circuits, No. 14 AWG minimum, unless shown otherwise on the Drawings.
- G. Multi-conductor underground feeder, branch-circuit, and control cable shall meet the requirements of Article 340 of the National Electrical Code.
- H. Use No. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 60 feet.
- I. Use No. 8 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet.
- J. Use No. 6 AWG conductors for 20 ampere, 120 volt branch circuits longer than 170 feet.
- K. Use No. 4 AWG conductors for 20 ampere, 120 volt branch circuits longer than 270 feet.
- L. Use No. 3 AWG conductors for 20 ampere, 120 volt branch circuits longer than 420 feet.
- M. Where conductors or cables are to be installed in non-metallic raceway systems, the Contractor shall allow 24 hours, minimum, for all solvents to evaporate after cementing the last joint before pulling wires or cables.
- N. Pull conductors into raceway at same time. Cable pulling tensions shall not exceed manufacturer's recommended values.
- O. Use suitable wire pulling lubricant for wire, No. 4 AWG and larger, and for cables. No soap flakes, vegetable oils, clays, or grease shall be permitted in raceways.
- P. Use suitable cable fittings and connectors.
- Q. Neatly train and lace wiring inside boxes, equipment, and panelboards. Wires and cables shall be bundled and laced as specified in Section 26 05 33.23 - Surface Raceways for Electrical Systems.
- R. Wires and cables routed through manholes, handholes, cable vaults, large pull boxes, and terminal cabinets shall be looped to provide two to three feet (minimum) of slack within the enclosure, where practical.
- S. Clean conductor surfaces before installing lugs and connectors.
- T. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- U. Wire and cable shall be supported in vertical runs by insulated clamps so that wire or cable weight will not be unduly supported from conductor terminations.
- V. Spade or fork tongue lugs shall not be used, except where approved by Owner.
- W. Conductor terminations and tap splices within lighting fixture pole/transformer bases shall be suitable for wet or damp locations.
- X. Wires and cables shall, in general, be run continuously, without splicing, from origination to termination. No splices shall be permitted in any feeder circuit, except in outlet, junction, and/or pull boxes, or where specifically noted on the Drawings. Use sufficient length of wire for connecting to equipment without straining. Methods of splicing shall meet cable manufacturer's recommendations. Splices shall be carefully placed in outlet boxes, etc. without crowding. No splicing shall be permitted in signal cables.
- Y. Splices and tap connections shall be made in junction boxes only; conduit type fittings shall not be used as junction boxes.
- Z. Wires and cables shall be installed in raceways, as indicated on the Drawings or required, and shall provide a complete and operating system.
- AA. Wires and cables shall be tagged as specified in Section 26 05 53 - Electrical Identification.

- BB. Motor control center feeder circuits and distribution panelboard branch circuits shall each be run in individual raceways from source to motor or other load.
- CC. Vertical lengths of wire and cable shall be supported as required by Article 300.19 of the National Electrical Code. Cable weight shall not be unduly supported from conductor terminations.
- DD. Vertical lengths of exposed cable or cord runs over ten feet long shall be supported with a strain relief.
- EE. Where an exposed run of cable or cord enters a box or enclosure, provide a watertight cord grip fitting suitable for the cable or cord diameter.
- FF. 120 VAC, single phase loads shall be connected to provide a balanced load on the lighting transformers. 480 VAC, single phase loads shall be connected to provide a balanced load on the 480 VAC, three phase system.
- GG. Make conductor length for parallel feeders identical on each phase leg.
- HH. Feeders shall be connected for correct phase rotation. Where possible, busses shall be connected to result in the "A" or "X" phase being in the north, east, or top position with the other phases following in sequence. Terminals H1, H2, and H3 of transformers shall be connected to A, B, and C; 1, 2, and 3; or X, Y, and Z conductors, respectively, of incoming feeders.
- II. Final connections to motors and other machinery, equipment and devices in hazardous areas which may be subject to movement or vibration may consist of a loop of mineral-insulated, metal-sheathed cable (Type MI) with UL listed fittings.
- JJ. Secondary wire and cables run exposed through manholes, handholes, and cable vaults shall be fireproofed, where exposed. Fireproofing of wire and cables shall be accomplished with half lapped taping using fireproofing tape made of heat resistant organic fabric coated on one side with a flame-retardant elastomer. Fireproofing tape shall be held in place by spiral wrapping at recommended intervals using woven fiberglass tape.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 26 05 53 - Electrical Identification.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.06 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Sections 01 45 00 - Quality Control and Section 26 07 05 - Electrical Testing and Equipment.
- B. Inspect wire and cable for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor.
- E. Verify continuity of each feeder conductor.
- F. Communication cables shall be tested and certified by a qualified third-party after installation in accordance with industry standards, and copies of the certified test results turned over to Owner.

END OF SECTION

SECTION 26 07 05 ELECTRICAL TESTING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to perform electrical testing as shown on the Drawings, specified or required.
 - 1. Building wire.
 - 2. Underground feeder and branch circuit wire
 - 3. Instrumentation cable
 - 4. Communications cables
 - 5. Wiring connectors and connections

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 00 - Quality Control
- B. Section 26 05 00 - Common Work Results for Electrical
- C. Section 26 05 10 - Basic Electrical Materials and Methods
- D. Section 26 08 00 - Calibration and Start-up of Systems

1.03 REFERENCE STANDARDS

- A. Testing methods shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Any and all Federal, State, and/or local codes, ordinances, or regulations.
 - 3. NETA Acceptance and Maintenance Specifications and Safety Guidelines.
- B. Equipment shall be tested in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL, and OSHA, except as modified herein.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01 33 00 - Submittal Procedures.
- B. Product Data: Indicate electrical characteristics and specifications; including layout of switches, buttons, displays, dimensions, weights, and external power requirements; and, list cables, connections and all available accessories.
- C. Test Results: Submit test results under provisions of Section 01 77 00 - Closeout Procedures.
- D. Operation and Maintenance Data:
 - 1. Submit under provisions of Section 01 77 00 - Closeout Procedures.
 - 2. Operation Data: Include bound copies of operating and programming instructions.
 - 3. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and use of product(s).

1.05 QUALITY CONTROL

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Cable testing shall be performed by technicians certified in accordance with ANSI/NETA ETT-2000 Standards for the Certification of Electrical Testing Technicians. Technicians performing

these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make an informed judgment on the continued serviceability or non-serviceability of the specific equipment. Each on- site crew leader shall hold a current certification, Level III or higher, in electrical testing.

1.06 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, and as acceptable to authority having jurisdiction, as suitable for purpose specified and indicated.
- B. Test instruments and devices shall be in conformance with all applicable standards and requirements of ISA, IEEE, ANSI, NEMA, and Underwriters Laboratories. NIST traceable certificates of calibration shall be provided with each instrument/device.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage. Turn over to Owner immediately.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. The work shall include, but is not limited to, the following major items:
 - 1. Programming.
 - 2. Testing, Start-up, Demonstration, and Training for all electrical, instrumentation and controls equipment and/or systems furnished and installed as a part of Division 26.

PART 3 EXECUTION

3.01 TESTING

- A. Contractor shall perform all testing necessary to ensure that the work performed under the Contract is satisfactory and in conformity with the requirements of the Contract Documents.
- B. Testing shall be performed prior to start-up of equipment or systems.
- C. Tests shall be witnessed by Owner and four (4) copies of all field tests, as specified herein and in other Sections, shall be submitted to Owner. Twenty-four (24) hours (minimum) written notice shall be given Owner prior to performing the tests. Such tests shall be scheduled at a time agreed upon by Owner and Contractor.
- D. Testing shall include, but shall not be limited to, the following tests:
 - 1. Insulation resistance to ground of conductors and equipment.
 - 2. Continuity, connections, and integrity of the facility's entire grounding system.
 - 3. Continuity, polarity, phase sequence, and connection of current carrying conductors and equipment.
 - 4. Ground fault detection systems shall be tested in accordance with the NEC, UL, and manufacturer's recommendations.
 - 5. Power Cable Tests shall be performed by a NETA full member testing company, supervised by a certified NETA testing leader, and made as follows:
 - a. New 480-volt feeder and branch circuit wires and cables between transformers and motor control center and distribution panelboard conductors shall be given a dielectric

absorption test. Dielectric absorption tests shall be made in accordance with NETA Acceptance and Maintenance Specifications and NETA Safety Guidelines.

- b. Wire insulation tests shall be made with a 1000-volt megger on 480-volt power distribution cables and/or wires. Each test shall be continued for a time sufficient to charge the cable or wire.
- 6. The following information shall be included in a test report on each cable:
 - a. Complete identification of cable, including approximate length.
 - b. Approximate average cable temperature.
 - c. Megger readings versus time data, including converted values (480-volt cables only).
- 7. In order to be acceptable, cable must withstand the specified high voltage without breakdown or have satisfactory megger readings.
- E. Improper connections, or materials, and equipment not adapted to the purpose for which it is intended, or material, or equipment found to be faulty while performing the tests, shall be corrected; and any changes or repairs necessary to put the work in satisfactory condition and operation shall be done by Contractor and re-tested at no additional cost to Owner.

3.02 CONTRACTOR'S ASSISTANCE

- A. Completely and thoroughly swab raceway before installing wire.
- B. Testing of package equipment shall be as required in other Sections.
- C. Provide the services of an electrician to assist either Contractor or the equipment manufacturer's service representatives on field test and adjustments as may be made or required by equipment manufacturers or the Contractor as the equipment is put into service. Contractor shall make equipment manufacturers' service representatives available as required to assist in testing or putting equipment into operation.

3.03 DEMONSTRATION

- A. After acceptance of the test equipment, Owner's operators shall be provided with one day (in two 1/2-day sessions) of onsite training in the use and maintenance of each piece of the equipment. Training shall cover the operation of the test equipment, preventative maintenance of equipment, and troubleshooting and repair/replacement procedures.

END OF SECTION

**SECTION 26 07 05.10
ELECTRICAL TEST CERTIFICATES**

Device Settings Certificate For Motor Protection Relay (MPR)

TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone Number: _____

EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

MPR Settings			
Device ID		Jam Trip Run Delay in Seconds	
Manufacturer		Underload Trip Level in % of FLA	
Model No.		Underload Trip and Alarm Start Delay in Seconds	
Full Load Amp Rating		Underload Trip Run Delay in Seconds	
Locked Rotor Current in % of FLA		Phase Unbalance Trip Level	
Maximum Allowable Stall Time in Seconds		Phase Unbalance Trip and Alarm Start Delay in Seconds	
Ultimate Trip Current in % of FLA		Phase Unbalance Trip Run Delay in Seconds	
Phase CT Ratio		Ground Fault Alarm Level in % of Ground CT Ratio	
Ground CT Ratio			

CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature: _____

Date: _____

ENGINEER REVIEW

Calibration Witnessed: _____ Yes _____ No

Reviewer Signature: _____

Date: _____

Device Settings Certificate for Circuit Breakers

TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone Number: _____

EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature: _____

Date: _____

ENGINEER REVIEW

Calibration Witnessed: ____ Yes ____ No

Reviewer Signature: _____

Date: _____

Device Settings Certificate for Variable Frequency Controller

TECHNICIAN INFORMATION

Company Name: _____

Contact Person: _____

Address: _____

Phone Number: _____

EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

CERTIFICATION

I certify that the above information is correct and that the instrument installation conforms to manufacturer and Contract Specifications, unless otherwise noted.

Technician Signature: _____

Date: _____

ENGINEER REVIEW

Calibration Witnessed: _____ Yes _____ No

Reviewer Signature: _____

Date: _____

END OF SECTION

SECTION 26 07 10 DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to demonstrate equipment and/or systems for Owner's personnel as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 00 - Quality Control
- B. Section 01 77 00 - Closeout Procedures
- C. Section 26 05 00 - Common Work Results for Electrical
- D. Section 26 05 10 - Basic Electrical Materials and Methods
- E. Section 26 07 05 - Electrical Testing and Equipment
- F. Section 26 08 00 - Calibration and Start-up of Systems

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electric Code (NEC)
- B. Federal, State, and/or local codes, ordinances, or regulations.
- C. Equipment shall be designed, constructed, installed, and tested in conformity with requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL and OSHA, except as modified herein.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DEMONSTRATION OF EQUIPMENT

- A. Demonstration of equipment and systems, and training of Owner's personnel in the proper operation and maintenance of the equipment and systems, shall be performed as described below, and per the requirements of the Section under which the equipment/system was furnished.
- B. The following shall occur prior to scheduling demonstration and training of equipment and/or system:
 - 1. Contractor shall have fully complied with the requirements of 26 07 05 - Electrical Testing and Equipment and Section 26 07 05.10 - Electrical Test Certificates and shall have submitted reports indicating successful completion of start-up for the equipment/system being started.
 - 2. Deficiencies in the manufacturer's Operation and Maintenance (O&M) Manuals and/or "As-Built" drawings, noted during Start-up shall be corrected prior to scheduling Owner's demonstration and training, as required per Section 26 07 10 - Demonstration and Training.
- C. After completing the above items, the Contractor shall schedule Owner's demonstration and training. Seventy-two (72) hours (minimum) written notice shall be given Owner's Representative prior to performing any demonstration and/or training. Such sessions shall be scheduled at a time agreed upon by Owner and Contractor. Multiple sessions shall be scheduled to allow attendance by Owner's personnel.
- D. Demonstration shall instruct Owner's personnel in facets, features and functions of the operation of the equipment and/or system. Training shall be performed using the

manufacturer's Operation and Maintenance Manual and "As-Built" drawings, and shall familiarize Owner's personnel in identifying improper operation, troubleshooting for the cause(s), and performing repair, replacement, and recalibration/setup necessary to correct the mis-operation. Use of test equipment necessary, and a review of recommended and/or provided spare parts shall be included in the training.

- E. Verification of the demonstration and training for the equipment and/or system shall be provided in the form of a report, indicating that Owner's personnel attended and witnessed all functions and operations required of the equipment and/or system, and received the required instruction. Demonstration and Training will be witnessed by Owner's Representative and four (4) copies of demonstration and training reports, as specified above and in other Sections, shall be submitted to Owner.
- F. Successful and approved completion of the Demonstration and Training requirements is a prerequisite to determining whether the Work or a portion of the Work is Substantially Complete.

3.02 CONTRACTOR'S ASSISTANCE

- A. Demonstration and training of package equipment, as described herein shall be as required in other Sections.
- B. Contractor shall provide the services of an electrician to assist either Contractor or the equipment manufacturers' service representatives on field set-ups and adjustments as may be required to demonstrate operation of the equipment or system. Contractor shall make equipment manufacturers' service representatives available as required to assist in demonstrating equipment operation.

3.03 CLEANUP

- A. Cleanup shall occur as required under Section 01 77 00 - Closeout Procedures.

3.04 ACCEPTANCE

- A. Acceptance shall occur after the above requirements have been satisfied, and as per Section 01 77 00 - Closeout Procedures.
- B. Acceptance of equipment and/or systems shall be signified by execution of guarantees as described below.

3.05 GUARANTEES

- A. Equipment and installation furnished under Division 26 shall be guaranteed for a period of one (1) year as specified under Section 01 77 00 - Closeout Procedures.
- B. Contractor's Guarantee shall be furnished as follows:
 - 1. Provide multiple copies.
 - 2. Execute for Owner's signature a certificate of Contractor's guarantee, listing date of acceptance as start of warranty period (except where indicated otherwise under the detailed equipment specifications), for work and materials provided and installed under this Division.
 - 3. Execute and assemble transferable warranty and/or license documents from Subcontractors, suppliers, and manufacturers.
 - 4. Provide Table of Contents and assemble in three D, side ring binder with durable plastic cover.
- C. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of Owner's acceptance as start of warranty period.

- D. Owner's dated signature on these documents shall constitute acceptance for warranty purposes.

END OF SECTION

SECTION 26 08 00 CALIBRATION AND START-UP OF SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to calibrate and start-up specified equipment and/or systems as shown on the Drawings, specified or required.
- B. This Section includes:
 - 1. Requirements for setup and calibration of devices and instruments.
 - 2. Requirements for start-up of systems furnished/installed under this Contract.
 - 3. Calibration equipment requirements.
 - 4. Sample Forms.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 00 - Quality Control
- B. Section 26 05 00 - Common Work Results for Electrical
- C. Section 26 05 10 - Basic Electrical Materials and Methods
- D. Section 26 07 05 - Electrical Testing and Equipment
- E. Section 26 08 00 - Calibration and Start-up of Systems

1.03 REFERENCE STANDARDS

- A. Setup, calibration, and workmanship shall be in conformance with the following documents:
 - 1. NFPA 70 - National Electric Code (NEC)
 - 2. Federal, State, and/or local codes, ordinances, or regulations.
- B. Equipment shall be designed, constructed, installed, and tested in conformity with requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL and OSHA, except as modified herein.

1.04 SUBMITTALS

- A. Product Data: Indicate electrical characteristics and specifications; including layout of switches, buttons, displays, dimensions, weights, and external power requirements; and, list cables, connections and all available accessories.
- B. Submit calibration, setup and programming documentation under provisions of Section 01 77 00 - Closeout Procedures.
- C. Operation Data: Include bound copies of operating and programming instructions. Include component parts replacement, adjustments, and preventative maintenance procedures and materials.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and use of product(s).

1.05 QUALITY CONTROL

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.

1.06 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, and as acceptable to authority having jurisdiction, as suitable for purpose specified and indicated.
- B. Instruments and devices shall be in conformance with applicable standards and requirements of ISA, IEEE, ANSI, NEMA, and Underwriters Laboratories.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 START-UP REQUIREMENTS

- A. Setup, calibration and start-up of equipment and/or systems shall be performed as described below, and per the requirements of the Section under which the equipment/system was furnished.
- B. Contractor shall also verify operation of the facility's main control and monitoring systems, and coordination with all other equipment and sub-systems.
- C. Prior to scheduling Start-up of any equipment and/or system, Contractor shall have complied with the requirements of Section 26 07 05 - Electrical Testing and Equipment and shall have submitted reports indicating successful completion of testing for the equipment/system being started.
- D. Prior to energizing and operating any equipment or system, Contractor shall arrange for the manufacturer's representative to inspect the installation for compliance to the manufacturer's recommendations. As a part of this inspection, Contractor and/or the manufacturer's service personnel shall set protective devices as required by the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses specified under 26 07 05 - Electrical Testing and Equipment.
- E. Contractor shall energize the equipment/system and perform setting of equipment limit and safety switches. Calibration of sensing relays, and timer/sequencer, etc. settings, along with programming required for proper operation shall be made at this time. Contractor shall then start-up the equipment/system and verify the proper operation of all features and functions as required by the Specifications and Drawings.
- F. After completing the above items, the Contractor shall schedule a "Witnessed" Start-up. Twenty-four (24) hours (minimum) written notice shall be given to Owner prior to performing any start-up. Start-up shall be scheduled at a time agreed upon by Owner and Contractor.
- G. Start-up and operation of the equipment and/or system shall be performed using the manufacturer's Operation and Maintenance Manual. Deficiencies in the O&M Manual noted during start-up shall be corrected prior to scheduling Owner's demonstration as specified under Section 26 07 10 - Demonstration and Training. Start-up will be witnessed by Owner.
- H. Verification of the start-up performance of the equipment and/or system shall be provided in the form of a start-up report, indicating that Owner's witnessed all functions and operations required of the equipment and/or system. Four (4) copies of start-up reports, as specified herein and in other Sections, shall be submitted to Owner.
- I. Improperly functioning equipment not adapted to the purpose for which it is intended, or material, or equipment found to be faulty while performing the tests, shall be corrected; and any

changes or repairs necessary to put the work in satisfactory condition and operation shall be done by Contractor at no additional cost to Owner. Start-up of the repaired equipment/system shall be witnessed by Owner.

- J. Successful and approved completion of the start-up requirements is a prerequisite to determining whether the Work or a portion of the Work is Substantially Complete as specified under Section 26 07 10 - Demonstration and Training.

3.02 CONTRACTOR'S ASSISTANCE

- A. Setup, calibration, and start-up of equipment as described in Section 26 07 05 - Electrical Testing and Equipment, shall be as required in other Sections.
- B. Contractor shall provide the services of an electrician to assist either Contractor or the equipment manufacturers' service representatives on field tests and adjustments as may be made or required by equipment manufacturers or the Contractor as the equipment is started up. Contractor shall make equipment manufacturers' service representatives available as required to assist in putting equipment into operation.

3.03 DEMONSTRATION

- A. Turn over the calibration equipment at the time of, and as a condition of, acceptance.
- B. After acceptance of the calibration equipment, Owner's operators shall be provided with one day (in 1/2-day sessions) of onsite training in the use and maintenance of each piece of the equipment. Training shall cover the operation of the calibration equipment, preventative maintenance of equipment, and troubleshooting and repair/replacement procedures.

END OF SECTION

SECTION 26 09 00
INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS - GENERAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes general requirements for electrical power, instrumentation, and controls systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 00 - Quality Control
- B. Section 26 05 00 - Common Work Results for Electrical

1.03 REFERENCE STANDARDS

- A. Equipment and workmanship shall be in conformance with the following documents:
 - 1. NFPA 70 - National Electric Code (NEC)
 - 2. Federal, State, and/or local codes, ordinances, or regulations.
- B. Equipment shall be designed, constructed, installed, and tested in conformity with requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL and OSHA, except as modified herein.

1.04 GENERAL REQUIREMENTS

- A. Unless otherwise specified, provide tools, equipment, apparatus, transportation, labor, and supervision to complete and place in satisfactory operation the work indicated on the Drawings and specified herein. Where permits or inspection fees are required in connection to the work under this Specification, Contractor shall secure such permits and pay all fees.
- B. Where public or private utilities are encountered, Contractor shall be responsible for any damages thereto resulting from his operations. Existing lines or utilities damaged during the construction, and which are not to be abandoned or removed, shall be replaced or repaired. Contractor shall be responsible for determining the exact location of all underground or otherwise concealed utilities, conduit runs, piping, etc. which may interfere with construction, or which require modifications.
- C. Work shall be done in conformity with the applicable requirements of the codes, rules, and regulations of public utilities and all others having jurisdiction.
- D. Where the Specifications describe or the Drawings show materials of higher quality than required by the above rulings and codes, the Drawings and Specifications shall govern the quality of materials which shall be furnished.
- E. Wire, conduit, and equipment sizes shown on the Drawings are based on estimated ratings. If ratings of equipment as furnished under the Contract exceed the estimated ratings, the wire, conduit, and equipment sizes shall be adjusted to meet NEC requirements at no additional cost to Owner.
- F. The phrase "below grade," when used in reference to the interior of buildings, rooms, or other structures in these Specifications and on the Drawings, shall apply to the entire internal volume of the room, area, or structure where 50 percent or more of the volume is actually below the average of the exterior finished grade elevations. In other cases, the phrase shall only apply to the volume of space actually below finished grade.
- G. Dry locations are defined as interior; above grade; heated rooms, structures, buildings, cabinets, enclosures, etc. not normally subject to dampness or wetness. Damp locations are defined as interior; above grade; unheated rooms, structures, and buildings. Wet locations are defined as all outdoor areas; all underground rooms, structures, building areas, vaults, etc.;

whether heated or unheated. Refer to National Electrical Code Article 100, "Location:" for additional definitions.

1.05 PROJECT CONDITIONS

- A. Before submitting his proposal, Contractor shall be held to have examined the site and satisfied as to the existing conditions under which Contractor will be obliged to work. Contractor will be allowed no claim(s) for extra(s) due to Contractor's failure to make the above examination.

1.06 INSPECT

- A. At the proper time, Contractor shall file application for inspection of his work with the local, State, or National authority having jurisdiction and shall deliver to Owner required certificates attesting to approval by such authorities.

1.07 GUARANTEE

- A. The equipment and installation furnished under this Section shall be guaranteed for a period of one (1) year as specified under Section 01 77 00 - Closeout Procedures, except as modified by the Division 26 specifications.
- B. Repair and maintenance for the guarantee period is the responsibility of Contractor and shall include all repairs and maintenance other than that which is considered as routine (This is replacement of lamps, oiling, greasing, etc.). Owner shall be the judge of what shall be considered as routine maintenance.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new, except where specifically identified otherwise.
- B. Materials and equipment shall be listed or labeled by Underwriters' Laboratories, Inc., except for materials and equipment not available from any source with such listing and/or labeling, or as specifically required by the Division 26 Sections.
- C. Conductor terminations, lugs, and connectors on all equipment supplied under this Contract shall be 75 degrees Celsius rated for copper conductors.
- D. Concrete for electrical work shall be ready-mix or transit mixed concrete to the requirements of ASTM C94/C94M, latest edition. Concrete shall have a compressive strength, after twenty-eight (28) days, of 3,500 psi (minimum).

2.02 LOOSE AND DETACHABLE PARTS

- A. Contractor shall retain loose and small detachable parts of the apparatus and equipment furnished under his Contract, until the completion of his work, and shall then turn same over to Owner or Owner's representative delegated to receive them and obtain from Owner an itemized receipt, therefore, in triplicate, Owner retaining the original. Contractor shall retain one copy of this receipt for his files and shall attach the other two to any request for final payment for the work.

2.03 STANDARDS

- A. Materials shall be new and shall conform as a minimum with NEMA, ANSI, and Underwriters Laboratories, Inc. (UL) in every case where such a standard has been established for the particular type of material in question.

2.04 SPARE PARTS

- A. Spare parts shall be provided for electrical equipment supplied under this Contract, as specified in individual Specification Sections, and shall be furnished and delivered to Owner. Spare fuses are specified under Section 26 07 05 - Electrical Testing and Equipment.

- B. Spare parts shall be packed and individually boxed for storing with each box labeled with the part's description including its part or catalog number, its use, and the equipment for which it is a part. Parts used during startup shall be replaced prior to acceptance.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Floor-mounted equipment shall be provided with a minimum 4-inch-high concrete pad, unless a higher dimension is shown (or called for) on the Drawings.
- B. Material and equipment furnished and installed by Contractor shall be completely protected against damage, pilferage, dampness, or abuse until turned over and accepted by Owner.
- C. Concrete shall be maintained in moist condition for at least five (5) days after placement, by means approved by Owner.
- D. The installation of all electrical, instrumentation, and control equipment shall meet the requirements of the State and Federal Occupational Safety and Health Statutes.

3.02 DRAWINGS AND MEASUREMENTS

- A. Equipment is shown in its general location, except where in certain cases the Drawings may include details giving the exact location and arrangement. Existing, underground or otherwise concealed utilities, piping, conduit runs, etc. indicated on the Drawings are shown in approximate locations and orientations only; Contractor shall field verify exact locations.
- B. Drawings shall be submitted in accordance with Sections 01 33 00 - Submittal Procedures and 01 77 00 - Closeout Procedures of these Specifications and as specified herein. No work shall be undertaken until Engineer has reviewed and approved the shop drawings. Only approved materials shall be installed, and only approved installation methods shall be used.
- C. Contract Drawings show the arrangement, general design, and extent of the systems.
- D. The Work is shown on the Drawings by symbols, as shown in a legend on the Drawings.
- E. Contract Drawings are not intended to be scaled for roughing-in measurements nor to serve as shop drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by Contractor. Field measurements necessary to determine the required quantities of materials and fitting the installation of all materials and equipment into the building construction shall be taken by Contractor.
- F. Installation drawings and manufacturer's shop drawings are required for all electrical, instrumentation, and control work. Installation drawings shall show panel layout, conduit connection sizes, and location and equipment foundations, details, and locations, accurately dimensioned. Exposed runs of conduit need not be dimensioned. Conduit layout and installation drawings shall be submitted for approval and shall show all conduit runs, complete from origination to termination, and shall indicate conduit sizes and fills, raceway system components, methods and spacing of supports, etc.
- G. Control schematics shall be provided for all new and modified existing control circuits. Control schematics shall use the ladder diagram type format incorporating line numbers, operation function statements, contact location line numbers with underlines indicating normally closed contacts. A description of operation of each device and complete written sequence of operation shall be provided with all control schematics. Format and symbols shall be as approved by Owner. Wire and terminal numbers shall be clearly shown.
- H. Upon completion of the work, complete record drawings shall be provided in accordance with Section 01 77 00 - Closeout Procedures.

3.03 STORING OF EQUIPMENT

- A. Equipment shall be stored in accordance with the manufacturer's recommendations. A letter from the manufacturer shall be provided stating those recommendations.

- B. Equipment which has been set in place but not in operation shall be protected from damage or deterioration from whatever causes in accordance with the manufacturer's recommendations until the equipment has been accepted by Owner.
- C. Wire and cable shall be stored on the original, manufacturer's reels, protected from the weather, and all cable end seals shall be maintained intact until the cable is installed.
- D. During construction, electrical equipment insulation shall be protected against absorption of moisture and metallic components shall be protected against corrosion by strip heaters, lamps, or other acceptable means. This protection shall be provided immediately upon receipt of the equipment and maintained continuously.

3.04 CLEANUP

- A. After substantial completion and prior to final acceptance, all electrical equipment shall be cleaned up, interior and exterior, to be free of dust and other foreign matter. Internal components shall be vacuumed, including windings of dry type transformers, and wiped free of dust.
- B. De-energization of equipment to accomplish the cleaning work shall be done at a time as approved by Owner.

3.05 PAINTING

- A. Exterior of enclosures shall be cleaned and touched up with matching paint where scratched or marred so that the exterior presents an "as new" appearance.
- B. Factory finished equipment shall be protected from damage during erection, thoroughly cleaned after erection, and touched up as required. If the factory finish has, in the opinion of Owner, been seriously damaged, the equipment shall be refinished as specified in Section 09 96 00 - Industrial Paints and Coatings.

3.06 SALVAGED ELECTRICAL EQUIPMENT

- A. Electrical equipment in the existing treatment facility that is removed and not reused shall be turned over to Owner or disposed of as directed by Owner.

3.07 SUBSTANTIAL COMPLETION

- A. Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete, in accordance with the Contract Documents, such that Owner can occupy the facilities and/or utilize the system for its intended use.
- B. Substantial Completion shall be determined by Owner and/or Engineer based on completion of Testing, Start-up, and Demonstration requirements as specified in Sections 26 07 05 - Electrical Testing and Equipment, 26 07 10 - Demonstration and Training, and 26 08 00 - Calibration and Start-up of Systems. See Section 01 77 00 - Closeout Procedures for additional requirements.

END OF SECTION

SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide distribution panelboards and lighting panelboards as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 53 - Electrical Identification
- D. Section 26 24 16.13 - Panel Components and Devices

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction
- B. NEMA AB 1 - Molded Case Circuit Breakers
- C. NEMA PB 1 - Panelboards
- D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- E. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- C. Record Drawings: Record actual locations of Products; indicate actual branch circuit arrangement.
- D. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY CONTROL

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products as required by manufacturer.
- B. Accept products on site in factory containers and inspect for damage.

PART 2 PRODUCTS

2.01 DISTRIBUTION PANELBOARDS

- A. The distribution panelboards shall be NEMA Type 12 rated and shall have overall doors. Boxes shall be made of galvanized steel and the fronts and doors shall be made of painted steel. The fronts shall be designed for surface or floor mounting as shown on the Drawings. The doors shall be equipped with flush hinges and locks. All locks shall be keyed alike and six keys shall be furnished and delivered to the Owner. Glazed directory frames and cards designating the branch circuits shall be mounted on the inside of each of the cabinet doors. The door and panel trim shall be given one primer coat and not less than two coats of ANSI 61 paint. The panelboards shall have ground buses for terminating ground conductors.
- B. The panelboards shall be of the circuit breaker type and shall be designed for 600 volt, 3 phase, 3 wire, 60 Hertz alternating current service, and shall be service entrance rated. The panelboards shall be equipped with main circuit breaker and bus and branch circuits of sizes as shown on the Drawings. Feed through lugs, sized the same as the main lugs, shall be included where space limitations require additional panelboard section(s) to accommodate the scheduled branch circuit breakers. All panelboard bus work shall be copper and all terminals or lugs shall be 75°C rated for copper conductors.
- C. The circuit breakers shall be of the molded case, bolt-in-place type with thermal magnetic trip and shall be 600 volt, quick-make, quick-break with indicating trip and 25,000 A. interrupting capacity minimum at 480 volts. Breaker handles shall clearly indicate the "on", "off", and "tripped" positions. Each circuit breaker shall be provided with a padlockable handle lock hasp.
- D. The panelboards shall be Eaton Cutler-Hammer, Square D by Schneider Electric Type NF, or General Electric.

2.02 PACKAGE POWER UNITS

- A. Package power units shall be listed by Underwriters' Laboratories, Inc., and shall feature a self-contained indoor/outdoor non-ventilated enclosure that incorporates a primary breaker, a dry type transformer, a secondary main breaker, and a secondary distribution section with plug-in feeder breakers.
- B. All interconnecting wiring between the primary breaker and transformer and between the transformer and secondary main breaker and distribution section shall be factory installed and inspected prior to shipment. Sound levels must fall within NEMA-ANSI standard levels according to kVA size.
- C. The transformer design shall be listed by UL and built in accordance with the latest revision of NEMA ST 1-4 and ANSI Standards for general purpose specialty transformers. Core and coil treatment shall be by immersion in an insulating resin system of the class equal to the temperature rise and shall be cured at temperatures to result in complete encapsulation of core and coil.
- D. All transformer, circuit breaker, and bus terminals or lugs shall be 75°C rated. All panelboard and transformer bus work shall be tinned copper.
- E. The transformer shall be 15 kVA; 115°C temperature rise, 480 volt, single phase primary; and 120/240 volt, single phase, 3 wire secondary.
- F. The secondary main breaker shall be 2 pole, sized to provide protection for the distribution feeder section.
- G. The primary of the transformer shall be protected by a molded case, thermal magnetic breaker. The primary breaker shall provide additional branch circuit protection and disconnecting means, as well as supplemental short circuit and overload protection for the transformer.

- H. The secondary distribution section shall accommodate one inch, plug-in breakers with 10,000 ampere interrupting capacity. Single pole and two pole breakers shall be provided as indicated on the Drawings. Primary, secondary main, and secondary feeder breakers shall have a hinged access door. The door shall have provisions for padlocking. Enclosure shall be NEMA Type 3R.
- I. Package power units shall be Square D by Schneider Electric Mini Power Zone, Hubbell -Acme Electric Panel Tran, Eaton Cutler-Hammer Mini Power Center, General Electric Service Center, or equal.

2.03 MODIFICATIONS TO EXISTING PANELBOARDS

- A. Where indicated on the Drawings, provide modifications to existing panelboards as required. The panelboards shall be modified by the addition of new devices, connections to existing devices, and/or disconnection from existing devices.
- B. Circuit breakers for addition to existing panelboards shall be the panelboard manufacturer's compatible replacement parts and shall match the panelboards existing breaker interrupting ratings. Breaker trip ratings and number of poles shall be as indicated on the Drawings.
- C. Existing lighting panels are General Electric, 120/208 volt, 3 phase, 4 wire panelboards.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and NECA 407-2015, Panelboards.
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Wall Mounting Height: 6 feet (2 m) to top of panelboard; install panelboards taller than 6 feet (2 m) with bottom no more than 4 inches (10 cm) above floor.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Panelboard circuit breakers or switches shall have a circuit number marker on or adjacent to the breaker or switch.
- G. Provide engraved plastic nameplates and circuit number markers under the provisions of Section 26 05 53 - Electrical Identification.
- H. Arc-flash and shock hazard warning labels shall be provided on the door of each panelboard.

3.02 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 07 05 - Electrical Testing and Equipment.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

END OF SECTION

SECTION 26 24 16.13
PANEL COMPONENTS AND DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide panel components and devices, and associated appurtenances as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 07 05 - Electrical Testing and Equipment
- B. Section 26 07 10 - Demonstration and Training
- C. Section 26 08 00 - Calibration and Start-up of Systems
- D. Section 26 09 00 - Instrumentation and Control for Electrical Systems - General

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electric Code (NEC)
- B. NEMA ICS 1 - Industrial Control and Systems General
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
- D. NEMA ICS 6 - Industrial Control and Systems: Enclosures

1.04 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, as acceptable to the authority having jurisdiction, and as suitable for purpose Specified, and as indicated on the Drawings.
- B. Equipment and workmanship shall be in conformance with all applicable standards and requirements of any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
- C. Products shall meet the latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories.

1.05 SUBMITTALS

- A. Shop Drawings: Shop drawings shall indicate electrical characteristics and connection requirements, including layout of complete assemblies, interconnecting cabling, dimensions, weights, and external power requirements for each Product supplied.
- B. Product Data: Provide product data showing manufacturer's specifications, electrical characteristics, and connection requirements for each product supplied. Include application and installation instructions indicating all conditions and limitations of use stipulated by the manufacturer, and/or testing agency, and any instructions for storage, handling, protection, examination, preparation, installation, and starting for each product supplied.
- C. Record Documents: Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.
- D. Operation and Maintenance Data:
 - 1. Installation and start-up requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.

2. Maintenance data shall include component parts diagrams and lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.

1.06 QUALITY CONTROL

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products as required by manufacturer.
 1. Store products in clean, dry area; maintain temperature to NEMA ICS 1.
- B. Accept products on site in factory containers and inspect for damage.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Panel components and devices shall be provided in enclosures, or housings, suitable for the environment of the intended installed location, as shown on the Drawings, and as described hereinbelow. Manufacturer shall provide integral heater(s) and/or cooler(s) where required for proper operation under normally expected conditions. Normal ambient temperatures at the facility site range from minus 30 to plus 45 degrees Celsius (minus 25 to plus 115 degrees Fahrenheit). Instruments in outdoor locations shall be suitable for operation under these conditions, while in direct sunlight, or under windy conditions with associated "chill" factors.
- B. Maintain instruments free of dirt and dust during and after installation.

PART 2 PRODUCTS

2.01 INSTRUMENT AND CONTROL PANELS - GENERAL

- A. Instrument and control panels shall be furnished as described in Section 26 41 16 - Panelboards, and as indicated on the Drawings.

2.02 TERMINAL BLOCKS – 600 VOLTS AND LESS

- A. Terminal blocks shall be as manufactured by Allen Bradley 1492-CA1 or equal by Eaton Cutler-Hammer or Square D.
- B. Each wire for external connection, and other wiring inside enclosures requiring terminal blocks, shall be terminated on screw type compression terminal blocks rated at 600 VAC. Fused terminals shall match the terminal blocks and shall be complete with fuse puller, and fuse.
- C. All foreign circuit 120 VAC wiring shall be yellow and each foreign circuit shall be provided with a clearly labeled circuit disconnect switch. Foreign circuit disconnect switches shall be switch type terminal blocks complete with engraved nameplates.
- D. Ten percent spare terminals of each type shall be provided.

2.03 POWER DISTRIBUTION BLOCKS – 600 VOLTS AND LESS

- A. Power distribution blocks shall be as manufactured by Allen Bradley 1492-PD type or equal by Eaton Cutler-Hammer or Square D.
- B. Where power is to be distributed among many circuits this shall be accomplished using one, two, or three pole power distribution blocks. The blocks shall be rated for use at 600 VAC and shall have copper connector block construction.

2.04 MANUFACTURERS (SWITCHES AND INDICATING LIGHTS)

- A. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 1, or NEMA Type 12, enclosures shall be of dust-tight, oil-tight NEMA Type 13 design; as

manufactured by Allen-Bradley Bulletin 800T, Eaton Cutler-Hammer 10250T Series, or Square D Type K.

- B. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 3R, or NEMA Type 4, enclosures shall be of watertight, NEMA Type 4 design; as manufactured by Allen-Bradley Bulletin 800T, Square D Type K, Eaton Cutler-Hammer 10250T Series with clear rubber boot and gaskets.
- C. Push-button switches, selector switches, and indicating lights mounted on NEMA Type 4X enclosures shall be of watertight, corrosion resistant, NEMA Type 4X design; as manufactured by Square D Type SK, Allen-Bradley Bulletin 800H with clear rubber boot and gaskets, or Eaton Cutler-Hammer 10250T Series with clear rubber boot and gaskets.
- D. Push-button switches, selector switches, and indicating lights mounted on explosion proof, (Class I, Div. 1, Groups C and D) enclosures shall be of explosion proof design, rated for Class I duty; as manufactured by Allen-Bradley Bulletin 800H, Square D Type BR, Crouse-Hinds Types EFS and EFD, Appleton EFD and EDS Series, or equal by Killark.
- E. Four or more position selector switches shall be rated as indicated above, as a minimum, with the number of contacts as required by the Drawings, shall have pistol grip type handles and shall be as manufactured by Electro Switch Type W-2, American Solenoid Blue Line Type C10, or equal.

2.05 INDICATING LIGHTS (LT)

- A. Indicating lights shall be LED, heavy duty, push-to-test, transformer type with lens colors as shown on the Drawings.
- B. Indicating lights shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.06 SELECTOR SWITCHES (SS)

- A. Selector switches shall be of the two or three position, maintained contact, heavy duty type, with contact arrangement as shown on the Drawings. The contacts shall be rated at least 10 amperes at 600 VAC.
- B. The selector switches shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.07 PUSH-BUTTON SWITCHES (PB)

- A. Push-button switches shall be of the heavy duty, momentary contact, industrial type rated for 600 VAC, and the contacts shall be rated for 10 amperes continuous duty at 125 VAC. Push-button switches shall be the guarded type with full shroud and green button for start operation, the unguarded type with red button for stop operation, and the unguarded type with black or gray button for all others.
- B. Push-button switches shall be equipped with legend plates marked as shown on the Drawings and shall be mounted on remote control stations as specified hereinafter or on other panels as shown on the Drawings.

2.08 EMERGENCY STOP-RESET/JOG PUSHBUTTON SWITCH STATIONS (ESRJ)

- A. Emergency stop-Reset/Jog pushbutton switch stations shall be of the three push-button operator type with padlocking provision on the Stop button. The switches shall be of the momentary (Reset and Jog buttons) – maintained (Stop button) type. The Stop and Reset operators shall be mechanically interlocked.
- B. Stations shall be rated for installation in hazardous locations; Class I, Division 1; where indicated as explosion proof; and shall be rated NEMA 4X for all other locations.

- C. Station enclosure shall be constructed of cast, copper-free aluminum with a corrosion resistant finish.

2.09 STOP-LOCKOUT SWITCH STATIONS

- A. Wherever "Emergency stop-Reset", "Emergency stop lockout", "Lock stop-Reset", "Stop lockout-Reset", or "Stop-Reset" pushbuttons are shown on the Drawings, they shall be two unit, mechanically interlocked, maintained contact type with locking device on stop button, and legend plates shall be "Stop" or "Emergency stop", as indicated on the Drawings, and "Reset".
- B. Stations shall be rated for installation in hazardous locations; Class I, Division 1; where indicated as explosion proof; and shall be rated NEMA 4X for all other locations.

2.10 REMOTE CONTROL STATIONS

- A. Control stations shall be provided and installed where indicated on the Drawings and shall contain the control devices indicated.
- B. Stations shall consist of switches and/or indicating lights mounted in a NEMA Type 4X, or explosion proof enclosure, as indicated on the Drawings. Station enclosures shall be designed for mounting of the control devices required and shall have nameplates as required and specified under Section 26 05 53 - Electrical Identification.

2.11 LOGIC RELAYS (LR)

- A. Logic relays shall be of the miniature plug-in relay type, suitable for logic duty, with contacts rated not less than 3 amperes at 120 VAC.
- B. The relay coils shall be rated for continuous duty at 120 volts, 60 Hertz. Each logic relay shall have an internal pilot light for indication of coil energization.
- C. The contact arrangement shall be 4PDT. Each relay shall also have a manual operator, to provide for testing the logic circuits by manually operating the contacts.
- D. Each logic relay shall be complete with a double tier, 14 pin (spade type), plug-in base. The bases shall be suitable for either surface or track mounting. Each relay shall be provided with a hold-down device.
- E. Logic relays shall be as manufactured by Square D Class 8501 Type R, Allen-Bradley Bulletin 700 Type P, or equal by IDEC or Potter and Brumfield a Division of Tyco Electronics.

2.12 CONTROL RELAYS (CR)

- A. Control relays shall be of the heavy duty, industrial type with convertible contacts rated not less than 10 amperes at 600 volts AC.
- B. The relay coils shall be of molded construction and shall be rated for continuous duty at 120 volts, 60 Hertz, alternating current.
- C. The contact arrangement shall be as required.
- D. NEMA Type 12 enclosures shall be provided for relays where shown on the Drawings.
- E. Induction relays shall be electro-mechanical type, 120 VAC powered with secondary coil voltage of 24 VAC and one N.O. and one N.C. contact rated 8 amps (min.) at 120 VAC. Induction relay sensitivity shall be field adjustable. Unit shall be suitable for use with contact closure devices.
- F. Control relays shall be as manufactured by Square D Class 8501 Type X, Allen-Bradley Bulletin 700 Type P, Eaton Cutler-Hammer Type ARB, or equal by General Electric.
- G. Induction relays shall be as manufactured by B/W Controls Model 1500-A-L1-S2-DC-X, or Warrick Controls equivalent.

2.13 ALTERNATING RELAYS (ALT)

- A. Duplex alternating relays shall be designed to alternate control of two loads through DPDT contacts. The relays shall be suitable for operation on 120 VAC. The contacts shall transfer on each pulse when the relay's control input is de-energized and shall be rated 5 amps (minimum) at 120 VAC resistive.
- B. Triplex alternating relays shall be designed to alternate control of three loads through SPST contacts. The relays shall be suitable for operation on 120 VAC. The contacts shall transfer on each pulse when the relay's control input is de-energized and shall be rated 2 amps (minimum) at 120 VAC resistive.
- C. The minimum life expectancy of the alternating relays shall be one million operations and each relay shall be equipped with screw terminals for direct wiring.
- D. Duplex alternating relays shall be as manufactured by Diversified Electronics Model No. ARA-120-ADA, or equal, by Time Mark.
- E. Triplex alternating relays shall be as manufactured by Diversified Electronics Model No. ARA-120-AFE, or equal, by Time Mark.
- F. Durant/Eagle Signal Model B856-511, or equal, with plug-in base and HOLD DOWN.

2.14 PHASE MONITOR RELAYS (PMR)

- A. Phase monitor relays shall sense phase loss, incorrect phase sequence, and low phase voltage and shall have double pole, double throw contacts. Relays shall operate on an adjustable voltage range of 440 volts to 480 volts. Relays shall have a delay on trip, field adjustable 1 to 10 seconds (minimum) and shall automatically reset when voltage returns to normal. Phase monitor relays shall detect phase loss with regenerated voltages present.
- B. Phase monitor relays shall be as manufactured by Diversified Electronics, Inc. No. SLD-440-ALE, or Time Mark Corp. Model C2642.
- C. Load monitor relays shall be as manufactured by Diversified Electronics, Inc. No. CBA-102-ALE-5, or equal.

2.15 LOAD MONITOR RELAYS (LMR)

- A. Load monitor relays shall be on the single phase, current monitoring type. Relays shall have adjustable, 1.0 to 5.0 amps, under current and over current ranges and shall operate on a 120 VAC source. Relays shall have an inherent 1.0 second delay, built in current transformer (CT), one set of Form C contacts each for under and over current rated 10 amps at 120 VAC, and shall automatically reset.
- B. Load monitor relays shall be as manufactured by Diversified Electronics, Inc. No. CBA-102-ALE-5, or equal.

2.16 DC LOOP POWER SUPPLIES

- A. Separately mounted dc power supplies shall be as manufactured by Acopian, or Power-One.

2.17 DC POWER SUPPLIES

- A. Each instrumentation device requiring a DC power supply shall each be powered by a single 24 VDC minimum, regulated 120 VAC input type power supply. Each power supply may be integral to an indicator or controller in the loop or may be of the separately mounted type. In the case of several instruments in a common case or enclosure, a single DC power supply may be provided for all devices, providing that the distribution of DC power to each device is separately protected by fuse or circuit breaker.
- B. Separately mounted dc power supplies shall be as manufactured by Acopian, or Power-One.

2.18 ELAPSED TIME METERS (ETM)

- A. Elapsed time meters shall have a range of 0 to 99,999.9 hours and shall be non-reset type suitable for panel mounting, with gasketing as required to maintain panel integrity (NEMA 12 or 4, as required).
- B. Elapsed time meters shall be as manufactured by General Electric Type 240, Simpson, or equal.

2.19 TOTALIZERS (QI)

- A. Each totalizer shall be a high accuracy, 8-digit, non-reset, front panel mounted instrument with bezel. The input shall be a scaled 24 VDC pulse, with gasketing as required to maintain panel integrity (NEMA 12 or 4, as required).
- B. The electric totalizers shall be as manufactured by Durant, KEP, or Sodecco.

2.20 PANEL HEATERS

- A. Heaters shall be as manufactured by Hoffman Engineering, or equal. Heaters shall be provided complete with thermostat, ranged 40 to 100 degrees Fahrenheit.
- B. Panel heaters and thermostats shall provide thermostatically controlled protection from low temperatures, and the effects of condensation inside control panels. Heaters shall be of the fan-forced type, to maintain stable temperatures throughout the enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make all instrumentation interconnections (process, electrical, etc.) as indicated and required for proper operation and intended use.
- D. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, and wire marker, etc. requirements.

3.02 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 07 05 - Electrical Testing and Equipment.
- B. Perform operational testing on instrumentation and control systems to verify proper operation and field wiring connections.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 26 07 05 - Electrical Testing and Equipment.
- B. Calibrate and/or verify each device for the zeros, ranges, and spans indicated on the Drawings.

3.04 DEMONSTRATION

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 07 10 - Demonstration and Training.
- C. After acceptance of the equipment, the Owner's operators shall be provided with one-half day (minimum) of onsite training in the use and maintenance of the equipment. The training shall cover the calibration of the devices, preventative maintenance of all equipment, and troubleshooting and repair/replacement procedures.

3.05 SPARES

- A. Spares for panel mounted components and devices shall be furnished as specified under Section 26 24 16 - Panelboards.
- B. Turn over all spares at the time of, and as a condition of, acceptance.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide modifications to existing motor control centers as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 53 - Electrical Identification
- D. Section 26 24 16.13 - Panel Components and Devices
- E. Section 26 07 05 - Electrical Testing and Equipment
- F. Section 26 07 10 - Demonstration and Training
- G. Section 26 08 00 - Calibration and Start-up of Systems
- H. Section 26 28 13 - Fuses

1.03 REFERENCE STANDARDS

- A. NECA 402 - Standard for Installing and Maintaining Motor Control Centers
- B. NEMA AB 1 - Molded Case Circuit Breakers
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
- D. NEMA ICS 2.3 - Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of MCCs Rated Not More Than 600 Volts
- E. NFPA 70 - National Electric Code (NEC)
- F. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type
- G. UL 198E - Class R Fuses

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Shop Drawings: Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time/current curves of all equipment and components.
- B. Wiring diagrams.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- E. The equipment shall not be released for manufacture prior to approval of and coordination with the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses.

- F. Record Documents: Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.
- G. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALITY CONTROL

- A. Perform Work in accordance with NEMA ICS 2.3.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.
- B. Deliver in shipping splits, individually wrapped for protection, and mounted on shipping skids.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.09 SPARE PARTS

- A. Furnish under provisions of Section 01 60 00 - Product Requirements.
- B. Furnish one (1) set of replaceable contacts for each type of relay and each size of contactor or starter installed in motor control centers modified under this Contract.
- C. Furnish three (3) push-to-test indicating light assemblies to match those installed in motor control centers modified under this Contract.
- D. Furnish ten (10) indicating light lamps.
- E. Furnish two (2) indicating light lenses of each color installed in motor control centers modified under this Contract.
- F. Furnish one (1) control switch assembly of each type installed in motor control centers modified under this Contract.
- G. For additional spare parts requirements, see Section 26 07 10 - Demonstration and Training.

PART 2 PRODUCTS

2.01 MODIFICATIONS TO EXISTING MOTOR CONTROL CENTERS

- A. The existing motor control centers shall be modified by the addition of new devices and by wiring revisions as shown on the Drawings.
- B. Starters for addition to existing motor control centers shall be of the magnetic type consisting of a circuit protective device in combination with a starter. The circuit protective device shall be a motor circuit protector type, molded case, air circuit breaker with interrupting capacity to match that of existing circuit breakers in the motor control center. The motor starter shall be comprised of NEMA size contactors; three pole, ambient compensating overload relays; interlocks; etc. The combination starters, Sizes 1, 2, and 3, shall be mounted on removable units designed to slide into the existing cubicles with stabs to engage the vertical bus and interlocks on the circuit protective device operating handle to prevent opening the unit door when the breaker is closed or in the "On" position. Individual 120 volt control circuit transformers with fused primary and with fused and grounded secondary shall be provided in each unit. Starters shall have a

spare auxiliary contact in addition to those indicated on the Drawings. Coils shall be rated for 120 volts, 60 Hertz operation. Additional control circuit transformer capacity shall be provided as required to safely carry all internal and external loads connected to it.

- C. Replacement or added motor overload protection shall consist of a UL 508 solid-state overload relay for protection of the motors. The relay shall be Allen Bradley type E3 Plus. The overload relay shall be self-powered and provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
- D. Devices on the front of unit shall be mounted as part of the removable unit.
- E. Nameplates shall be installed on the door of each unit and shall be attached by means of corrosion resistant screws. The plates shall be 1-1/4" high by 3-1/2" wide (minimum), white laminated plastic with engraved black letters. Letters shall be 1/8" high (minimum), block type. Nameplate engraving shall be as indicated in schedules on the Drawings, except nameplates for spare units shall be furnished blank. See the Drawings for nameplate details.
- F. All equipment devices mounted within the units shall be identified as to function and schematic identification abbreviation. Identification plates shall be 1" by 3" engraved white lamicaid with black letters, attached with corrosion resistant screws.
- G. Circuit protective devices shall be provided in accordance with the Short Circuit and Protective Devices Coordination Analyses specified under Section 26 07 05 - Electrical Testing and Equipment.
- H. Added control devices shall be as specified in Section 26 09 00 - Instrumentation and Control for Electrical Systems - General.
- I. Branch feeder protection shall be thermal magnetic, molded case, circuit breakers of frame and ratings sizes as indicated on the Drawings and with interrupting capacity to match that of existing circuit breakers in the motor control center. Circuit breakers shall have auxiliary normally open and normally closed contacts and Devicenet System Accessory for connection to the MCC PLC.
- J. The number and size of starters, contactors, and branch feeder circuit breakers added to each motor control center shall be as indicated on the Drawings and shall fit into the space shown.
- K. Each added or modified starter, contactor, and/or circuit breaker shall have a reduced size, approved, "as-built," schematic wiring diagram, in ladder diagram format, inside each unit, indicating all internal components and wiring terminal strip connections, all 480 volt power wiring, all 120 volt control and power wiring, all instrument wiring, and all external components and wiring (shown dotted). Wiring diagrams shall have a plasticized coating to protect them from dirt, heat, and normal wear and tear.
- L. Terminal blocks shall be installed, where required, to provide terminal block connections for all wiring to devices external to the motor control centers. All power feeder terminals or lugs shall be 75°C rated for copper conductors. Terminal blocks for control and alarm connections shall match the existing terminal blocks or shall be Allen-Bradley Types CA-1, CA-3, or CD-8; Square D Co.; or equal.
- M. Wire for control and alarm wiring revisions within the motor control centers shall be No. 14 AWG minimum, Type MTW, 60°C. All wiring installed within a motor control center, which is powered from sources external to the MCC, shall be color coded yellow.
- N. Door mounted control devices shall be furnished with anti-rotation keyways or other device to prevent slewing after mounting. Existing motor control centers are Allen-Bradley IntelliCENTER - Centerline Bulletin 2100.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify conditions under the provisions of Section 01 60 00 - Product Requirements.
- B. Verify that area is suitable for motor control center installation.

3.02 INSTALLATION

- A. Install motor control center components in accordance with manufacturer's instructions and per NECA 402-2014 Standards.
- B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.
- C. Install fuses in fusible switches.
- D. Select and install heater elements or set solid state overload relays in motor starters to match installed motor characteristics. Contractor shall assume full responsibility for the selection and installation of the proper rating of thermal heater elements or the settings on solid state overload relays in all motor starters to which Contractor makes the feeder connections and/or completely wires.
- E. Provide labels and engraved plastic nameplates under the provisions of Section 26 05 53 - Electrical Identification.
- F. Motor Data: Provide neatly typed label inside each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- G. Arc flash and shock hazard warning labels shall be provided on an upper door of each vertical section and shall be marked as specified in Section 26 05 53 - Electrical Identification.

3.03 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 01 45 00 - Quality Control and Section 26 07 05 - Electrical Testing and Equipment.
- B. Inspect and test each added or modified controller to NEMA ICS 2.

END OF SECTION

SECTION 26 27 16 CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide the following items, as shown on the Drawings, specified or required:
 - 1. Cabinets.
 - 2. Terminal boxes.
 - 3. Accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 33.16 - Boxes for Electrical Systems
- D. Section 26 05 33.23 - Surface Raceways for Electrical Systems
- E. Section 26 05 53 - Electrical Identification

1.03 REFERENCE STANDARDS

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- B. NEMA ICS 4 - Application Guideline for Terminal Blocks
- C. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- C. Certified shop drawings and diagrams shall be furnished and delivered for approval as follows:
 - 1. General dimensions and outline drawings showing the principal dimensions of the equipment and the location and size of electrical conduit connections.
 - 2. Detailed drawings, descriptive data, and other data sheets showing design information which verified that the equipment meets the technical requirements of the Specifications.

1.06 QUALITY CONTROL

- A. Perform Work in accordance with NEMA ICS 2.3.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

1.08 SPARE PARTS

- A. Furnish under provisions of Section 01 60 00 - Product Requirements.

- B. Provide three (3) of each cabinet key.

PART 2 PRODUCTS

2.01 CABINETS AND HINGED COVER ENCLOSURES

- A. Manufacturers: Manufacturers and model numbers of cabinets, enclosures, and associated components shall be as follows:
 - 1. Cabinets and Enclosures: Hoffman Engineering Co., Saginaw Controls, Stahlin, or Hammond.
 - 2. Anti-condensation Heaters: Saginaw Control & Engineering No. SCE-AHC50 or equal.
 - 3. Terminal Blocks: Allen-Bradley No. 1492-CA1, CA3, or -CD8.
 - 4. Substitutions: Items of equal function and performance are acceptable, if in conformance with all sections of this Specification.
- B. Cabinets and enclosures in dry locations shall be dust and oil tight, rated NEMA Type 12, and of 14 gauge (minimum) painted sheet steel construction or comparable non-metallic.
- C. Cabinets and enclosures in wet locations shall be watertight, rated NEMA Type 4, and of 14 gauge (minimum) painted sheet steel construction or comparable non-metallic.
- D. Cabinets and enclosures in corrosive areas shall be water, dust, and sleet tight, rated NEMA Type 4X, and of stainless steel construction or comparable non-metallic.
- E. Doors shall be equipped with a padlockable latch or padlock hasp and shall be provided with one (1) padlock with three keys.
- F. The top, sides, and doors of outdoor cabinets and enclosures shall be insulated with a 2-inch thick layer of extruded polystyrene material.
- G. The doors shall be gasketed.
- H. Provide an internal, mild steel sub-plate for mounting of internal components.
- I. Provide and install two (2) minimum, 120 volt, anti-condensation heaters within each outdoor cabinet or enclosures. The heaters shall be of the self-limiting type, 50 watts, 120 VAC.
- J. Cabinets and enclosures shall be provided with full-length door hinges. Hinges shall be stainless steel and the doors shall have a one point latch.
- K. Interior cabinet or enclosure surfaces, except fittings, shall be painted with two coats of primer and two coats of white, high gloss, baked epoxy enamel paint. The exterior shall be painted with one coat of primer, two coats of ANSI 61 gray paint, and a final coat of clear polyurethane.
- L. Terminal blocks shall be provided for all wiring entering cabinets and enclosures from external devices. Provide 10 percent spare terminals in addition to those required.
- M. Terminal boxes shall be similar to cabinets and enclosures, except they shall have screw covers in lieu of hinged and latched doors.

2.02 EXPLOSION PROOF CABINETS, ENCLOSURES, AND TERMINAL BOXES

- A. Explosion proof cabinets, enclosures, and terminal boxes shall be cast iron or cast aluminum with external mounting ears for surface mounting, internal mounting plate, hinged cover with stainless steel bolts and NEMA Type 4 seal, explosion proof, Class I, Division 1, Group D with bossed, drilled, and tapped conduit entrances as required for conduit and fitting connections as indicated on the Drawings. Explosion proof boxes shall be factory or field coated with a corrosion resistant, epoxy paint.
- B. Terminal blocks for power conductor connections shall be power distribution blocks for connection of copper wire with individual, set screw type connectors for each terminated conductor, Gould Shawmut 66000 Series, Marathon 143 Series, or equal. Terminal blocks for

control conductor connections shall be of the screw terminal type, number of blocks as required, Allen-Bradley No. 1492-CA1 with associated mounting devices, Square D, or equal.

- C. Provide an insulating barrier between the power and the control terminations.
- D. Explosion proof terminal boxes shall be Hope Electrical Products Co. H6000 Type, Crouse-Hinds Style C Series EJB, or equal.

2.03 TERMINAL BOXES

- A. Explosion proof terminal boxes for connection of the submersible dewatering and sample pump motor cable(s) shall be provided where shown on the Drawings. The terminal box shall be 12" high by 18" wide by 8" deep minimum with internal mounting plate for terminal blocks, cast iron or cast aluminum with external mounting ears for surface mounting, hinged cover with stainless steel bolts and NEMA Type 4 seal, explosion proof, Class I, Division 1, Group D with bossed, drilled, and tapped conduit entrances as required for conduit and fitting connections as indicated on the Drawings. Explosion proof terminal boxes shall be factory or field coated with a corrosion resistant, epoxy paint.
- B. Terminal blocks for power conductor connections shall be power distribution blocks for connection of copper wire with individual, set screw type connectors for each terminated conductor, Gould Shawmut 66000 Series, Marathon 143 Series, or equal. Terminal blocks for control conductor connections shall be of the screw terminal type, number of blocks as required, Allen-Bradley No. 1492-CA1 with associated mounting devices, Square D, or equal. Control terminal blocks and conductors shall be coated with a conformal coating compound after permanent terminations have been completed. Conformal coating compound shall be Chemtronics Konform, GC Electronics Conkoat, or equal. Provide an engraved, laminated plastic instruction plate, adjacent to the control terminal block, engraved: "RECOAT CONTROL TERMINATIONS WITH CONFORMAL COATING COMPOUND AFTER EACH RETERMINATION OF CONDUCTORS TO PREVENT NUISANCE MOTOR LEAK ALARMS".
- C. Provide an insulating barrier between the power and the control terminations.
- D. Explosion proof terminal boxes shall be Hope Electrical Products Co. H6000 Type, Crouse-Hinds Style C No. EJB181208-N4-MP-S598-S391, or equal.

2.04 ENCLOSURE ACCESSORIES

- A. Hardware on the exterior of NEMA Type 4 and NEMA Type 4X enclosures, including hinge pins, screws, bolts, nuts, washers, etc., shall be made of 300 series stainless steel.
- B. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal. Combination drain and breather shall be Stahlin Drain Vent or equal on NEMA Type 4X enclosures.
- C. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify conditions under the provisions of Section 01 60 00 - Product Requirements.
- B. Verify that surfaces are ready to receive work.

3.02 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- C. Install cabinet fronts plumb.

- D. All equipment installed in hazardous areas shall be provided in explosion proof enclosures, except equipment listed as intrinsically safe may be provided in NEMA Type 4 or non-metallic NEMA Type 4X enclosures. All explosion proof enclosures shall be factory or field coated with a corrosion resistant finish.
- E. NEMA Type 4 and Type 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub.
- F. All internal cabinet and enclosure components shall be mounted on the sub-plate positioned for easy access, convenient wiring, and for easy removal.
- G. Convenience receptacle mounted within cabinets and enclosures shall be mounted in a handy box with a cover plate.
- H. See Section 26 05 33.23 - Surface Raceways for Electrical Systems for conduit entrance to cabinets and enclosures requirements.
- I. Mark or label all boxes, cabinets, and enclosures as specified in Section 26 05 53 - Electrical Identification.
- J. The threads of all corrosive area, hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, pull and junction box covers, cable fittings, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- K. Cabinets and enclosures shall be mounted to walls, columns, machine frames, etc., with 1/2" separation from same, and all necessary spacers, brackets, structural pieces, inserts, anchors, and bolts shall be provided.
- L. Termination of the submersible dewatering and sample pump motor cable(s) at the terminal box shall incorporate a cord connector, a sealing fitting, and an explosion proof union fitting for each cable. The end of the cable's overall jacket shall be potted within the seal-off fitting in accordance with Article 501.5(D) of the National Electrical Code. The cable's overall jacket shall be stripped back to provide sufficient lengths of individual conductors for proper termination within the terminal box.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide the following items, as shown on the Drawings, specified or required:
 - 1. Wall switches.
 - 2. Receptacles.
 - 3. Device plates and box covers.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 33.16 - Boxes for Electrical Systems

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction
- B. NEMA WD 1 - General Color Requirements for Wiring Devices
- C. NEMA WD 6 - Wiring Devices - Dimensional Specifications
- D. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, materials, finishes, and configurations.
- B. Submit manufacturer's installation instructions.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.01 WALL SWITCHES

- A. Switches for local control of 120-volt lighting shall be quiet, quick make, slow break design with totally enclosed case, flush type, single pole, toggle switches, 20 ampere capacity at 120/277 volts. Switches shall be UL listed and shall meet NEMA WD 1.
- B. Two pole, 3-way, 4-way, and key switches shall have similar ratings.
- C. Where pilot lights are indicated, provide switches as specified above plus a separate pilot receptacle with plate and bull's eye in a two gang box.
- D. Lighting switches shall be Hubbell Series HBL1220, Leviton Series 1220, General Electric GE5951, Cooper Wiring Devices, or equal.
- E. Lighting switches installed in corrosive areas shall consist of switches as specified above installed in non-metallic corrosion resistant, FD type boxes with weatherproof, corrosion

resistant, flexible silicone rubber, bubble type covers; Hubbell No. HBL1795, Pass & Seymour No. 4517, or equal.

2.02 RECEPTACLES

- A. Duplex receptacles shall be 20-amp, 125-volt, 3 wire, grounding type, Hubbell Cat. No. HBL5362, General Electric GE5362, Cooper Wiring Devices No.5362B, or equal. Covers for general use receptacles shall be Crouse-Hinds Co. No. DS23G, Leviton 5362, Appleton Electric Co., or equal.
- B. Duplex receptacles installed in corrosive areas shall consist of a 20-amp, 125-volt, 3 wire, grounding type, corrosion resistant receptacle; Hubbell Cat. No. HBL53CM62, Leviton 53CM-62, General Electric GE0526C, Cooper Wiring Devices No. 5362CRY, or equal mounted in a non-metallic, corrosion resistant box with a corrosion resistant, weatherproof cover; Carlon, TayMac Corp., or equal.
- C. G.F.C.I. duplex receptacles shall be 20-amp, 125-volt, 3 wire, ground fault circuit interrupter type receptacles with face mounted "test" and "reset" pushbuttons and matching stainless steel cover plate. G.F.C.I. receptacles shall be Hubbell Cat. No. HBL GF-5362-I, Leviton 6898-I, General Electric GFR5362, Cooper Wiring Devices, or equal.

2.03 WALL AND COVER PLATES

- A. Where switches and receptacles are installed in concealed boxes, they shall be provided with Type 302 stainless steel cover plates.
- B. Where switches are installed surface mounted, they shall be installed in Type FD boxes with mounting lugs and provided with surface mounting covers. Covers shall be weatherproof where required, Crouse-Hinds No. DS181 or equal.
- C. Weatherproof receptacle covers shall be raintight while in use, NEMA Type 3R rated, UL listed and marked for use in Wet Locations with plug-cap inserted, and shall be made of impact resistant, ultraviolet inhibiting polycarbonate; TayMac Corp. with deep cover, Thomas & Betts WT Series with deep lid, Intermatic Flexi-Guard Series, Carlon E9U In-Use Series, or equal.
- D. Weatherproof covers for single receptacles shall be UL listed and marked for use in Wet Locations, gasketed, cast alloy with spring closed door, Hubbell No. HBL7420, Cooper Wiring Devices, or equal.
- E. Padlockable cover plates for switches and/or receptacles shall be weatherproof, die-cast aluminum with gasket, Killark WCV Series or equal.
- F. For general use switches located in areas designated hazardous, boxes and covers shall be explosion-proof, single gang with rocker arm type operating handles. Covers and boxes shall be catalog No. EFD-175-NL-Q and No. EFK-R12-Q as manufactured by Appleton Electric Co., Crouse-Hinds, or equal.

2.04 MISCELLANEOUS

- A. Anti-seize, lubricating, and protective compound shall be Never-Seez as manufactured by Bostik Div. of Emhart Corp., "Dry Molybdenum Lubricant" No. 40-640 by Ideal Industries, CRC Chemicals Lectra-Shield, Crouse-Hinds HTL, Sanchem, Inc. NO-OX-ID "A Special", or equal.
- B. Metallic, except stainless steel, device boxes, outlet boxes, cover plates, fittings, supports, hangers, and other exposed metal components installed in areas classified as hazardous and in corrosive areas shall be factory encased in polyvinyl chloride of minimum 0.040-inch (40 mil) thickness. Where factory PVC coating is not available or where PVC coating would void UL listing or labeling, factory or field coating with a corrosion resistant, epoxy paint shall be provided.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify conditions under the provisions of Section 01 60 00 - Product Requirements.
- B. Verify that outlet boxes are installed at proper height.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 INSTALLATION

- A. Install in accordance with NECA 1.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top.
- E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- F. Where more than one switch occurs in the same location, they shall be installed in gang type boxes.
- G. Duplex receptacles, shown on the Drawings outdoors or below grade, shall be mounted in weatherproof boxes and cover plates. Boxes shall be rust proof, cast metal having threaded openings for conduit connections and shall be mounted horizontally on or in the wall.
- H. Receptacles in dry, indoor locations shall be installed in surface mounting, Type FD boxes with mounting lugs.
- I. The threads of all hazardous area, outdoor, and below grade equipment connections including conduit, conduit fittings, outlet box connections, wiring device boxes, cover plate screws, etc. shall be coated with an anti-seize, lubricating, and protective compound prior to final assembly.
- J. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, wire marker, etc. requirements.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems to obtain mounting heights specified or indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

- A. Inspect Each Wiring Device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Refer to Section 01 77 00 - Closeout Procedures with regard to cleaning installed work.
- B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 28 13 FUSES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide fuses as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09 96 00 - Industrial Paints and Coatings
- B. Section 26 05 00 - Common Work Results for Electrical
- C. Section 26 05 10 - Basic Electrical Materials and Methods

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses
- B. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Product Data: Provide data sheets showing electrical characteristics including time-current curves and fuse let-through values for fault current available.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.01 FUSES

- A. Acceptable Manufacturers:
 - 1. Bussmann
 - 2. Mersen
 - 3. Edison
 - 4. Littelfuse
- B. Requirements:
 - 1. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
 - 2. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
 - 3. Fuses shall be dual element or current limiting type, Class R, or as otherwise required for installation in the equipment furnished, and as shown on the Drawings. Fuses shall provide type II protection for motor circuits.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

- C. Fuse holders shall be provided with fuses.
- D. Contractor shall replace all blown fuses and the quantities specified above shall be turned over to the Owner at the time of completion.
- E. Spare fuses shall, be packed and boxed for storing with each box labeled with fuse rating, class, etc.

END OF SECTION

SECTION 26 28 16.13 CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide circuit breakers as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 53 - Electrical Identification

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction
- B. NEMA AB 1 - Molded Case Circuit Breakers
- C. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Shop Drawings: Indicate voltage, short circuit ampere rating, circuit breaker arrangements and sizes.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- C. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- D. Record Documents: Record actual locations of Products; indicate actual branch circuit arrangement.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

1.07 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

PART 2 PRODUCTS

2.01 CIRCUIT BREAKERS

- A. Circuit breakers shall be of the bolt-in-place type using single pole or common trip, two or three pole as indicated on the Drawings. Circuit breakers shall be of the molded case type with thermal magnetic trip and breaker handles indicating "on" - "off" and "trip" positions. Ground fault circuit interrupter (GFCI) type breakers shall be provided where indicated on the Drawings. Breakers shall have 22,000 ampere interrupting capacity minimum and shall be

approved for "switching duty". Circuit breakers shall be Eaton-Cutler-Hammer, Square D by Schneider Electric, or ABB.

- B. Enclosures for individually mounted circuit breakers shall be similar to those for disconnect switches as specified in Section 16441, including padlockable operating handle.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install circuit breakers in accordance with manufacturer's instructions.
- B. Circuit breakers shall have a circuit number marker or equipment designation nameplate on or adjacent to the breaker.
- C. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, labeling, etc. requirements.

3.02 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 07 05 - Electrical Testing and Equipment.
- B. Arrange circuits on the transformer secondary to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

END OF SECTION

SECTION 26 28 16.16 ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide non-fusible disconnect switches as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 26 - Grounding and Bonding
- D. Section 26 05 29 - Hangers and Supports for Electrical Systems
- E. Section 26 05 33.16 - Boxes for Electrical Systems
- F. Section 26 05 53 - Electrical Identification
- G. Section 26 28 13 - Fuses

1.03 REFERENCE STANDARDS

- A. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
- B. NFPA 70 - National Electric Code (NEC)

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Product Data: Provide switch ratings and enclosure dimensions.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.01 DISCONNECT SWITCHES

- A. 600 volt rated, explosion proof disconnect switches shall be Eaton Crouse-Hinds, Emerson Appleton Electric Co. Type EDS, or Hubbell-Killark.
- B. Auxiliary interlocks shall be provided where shown on the Drawings.
- C. Disconnect switches shall have provisions for padlocking in either the "On" or "Off" positions and all terminals or lugs shall be 75°C rated for copper conductors. Fused switches shall utilize Class R fuses.
- D. Enclosures shall be NEMA 4X stainless steel, or explosion proof, as indicated on the Drawings.
- E. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install disconnect switches where indicated.
- B. Install fuses in fusible disconnect switches.
- C. Provide heavy duty, 3 pole, 600 volt, non-fused or fused disconnect switches through 100 amperes at locations indicated or as required.
- D. NEMA 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub.
- E. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, labeling, etc. requirements.
- F. Arc-flash and shock hazard warning labels shall be provided on the door of each switch enclosure and shall be marked as specified in Section 26 05 53 - Electrical Identification.

END OF SECTION

SECTION 26 29 13 ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment, and incidentals to provide magnetic motor starters and combination magnetic motor starters as shown on the Drawings, specified or required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33.16 - Boxes for Electrical Systems
- E. Section 26 05 53 - Electrical Identification
- F. Section 26 28 13 - Fuses
- G. Section 26 24 16.13 - Panel Components and Devices

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction
- B. NEMA AB 1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
- F. NFPA 70 - National Electric Code (NEC)
- G. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.
- H. UL 198E - Class R Fuses.

1.04 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. or other testing firm acceptable to authority having jurisdiction, as suitable for purpose specified and shown.

1.05 SUBMITTALS

- A. Product Data: Provide switch ratings and enclosure dimensions.
- B. Test Reports: Indicate field test and inspection procedures and test results.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- D. The equipment shall not be released for manufacture prior to approval of, and coordination with, the Short Circuit, Flash Hazard, and Protective Devices Coordination Analyses.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00 - Product Requirements.

1.08 SPARE PARTS

- A. Furnish under provisions of Section 01 77 00 - Closeout Procedures.
- B. Furnish one (1) set of replaceable contacts for each type of relay and each size of contactor or starter installed in motor controllers furnished under this Contract.
- C. Furnish three (3) push-to-test indicating light assemblies to match those installed in motor controllers furnished under this Contract.
- D. Furnish ten (10) indicating light lamps.
- E. Furnish two (2) indicating light lens' of each color installed in motor controllers furnished under this Contract.
- F. Furnish one (1) control switch assembly of each type installed in motor controllers furnished under this Contract.
- G. For additional spare parts requirements, see Section 26 00 00 - General Requirements for Electrical Work.

PART 2 PRODUCTS

2.01 MAGNETIC MOTOR STARTERS

- A. Full voltage starters shall be combination motor circuit protector type, unless otherwise noted, and motor starter complete with three pole, ambient compensating overload relays, and control circuit transformer. Starters shall be equipped with a spare auxiliary contact in addition to those shown on the Drawings, shall be minimum NEMA Size 1, and shall have 120 volt coils.
- B. Where indicated on the Drawings, starters shall include ground fault protective devices. The ground fault protective devices shall include a current transformer, a ground fault relay, and test circuit and shall be suitable for interrupting the starter control circuit. Ground fault monitoring and test devices shall be mounted on the starter door and shall include a trip indicator, a manual reset button, and a test button. Testing with or without tripping shall be possible.
- C. Starters shall be electrically operated and held type, three pole assemblies with coil, contact assemblies, and integral overload protection. Coil shall be warranted for life.
- D. Motor overload protection shall consist of a thermal overload relay of the three pole, ambient compensating, manual reset, and solid state type.
- E. Solid state motor overload protection shall include time-current characteristics and shall be field selectable or adjustable. Accuracy shall be within 2%. Solid state overloads shall monitor three phase motor current utilizing three current sensors. The trip Class 10, 20, and 30 shall be field selectable and provide 10, 20, or 30 second delay at six times the full load running protection respectively. Solid state overloads shall be manually reset with the ability to convert to automatic reset in the field. Overload relay shall have two outputs: 1) an alarm indicator indicating motor is running in overload and, 2) an overload trip indicator.
- F. Oiltight pushbutton and selector switches and push-to-test, transformer type, indicating lights shall be provided as indicated on the Drawings. Control devices mounted on doors of NEMA Type 4 enclosed starters shall be NEMA Type 4 rated. All starters with manual reset overload relays shall have an external overload reset pushbutton mounted on the enclosure door.
- G. Control devices shall be as specified under Section 26 24 16.13 - Panel Components and Devices.
- H. Starters shall have NEMA Type 12 enclosures where mounted indoors, stainless steel NEMA Type 4 enclosures where outdoors or below grade indoors, or non-metallic NEMA Type 4X enclosures in corrosive locations, unless otherwise shown on the Drawings. All hardware on the exterior of NEMA Type 4 enclosures, including hinge pins, screws, bolts, nuts, washers, etc., shall be made of stainless steel.

- I. Control circuit transformers shall have fused primary windings and 120 volt, fused, and grounded secondary windings. Control circuit transformers shall have extra capacity where required to carry connected loads.
- J. Fuses shall be as specified under Section 26 28 13.
- K. All unit line and load terminals or lugs shall be 75°C rated for copper conductors. Terminal boards or blocks shall be provided for all external connections and shall be readily accessible from the front of the starter enclosure. All wiring to external devices shall be terminated at the terminal blocks, excluding incoming power feeders and motor leads. All wires and terminals shall be tagged to agree with schematic and wiring diagrams.
- L. Each starter shall have a reduced size, approved, "as-built," schematic wiring diagram, in ladder diagram format, inside each unit, indicating all internal components and wiring terminal strip connections, all 480 V. power wiring, all 120 V. control and power wiring, all instrument wiring, and all external components and wiring (shown dotted). Wiring diagrams shall have a plasticized coating to protect them from dirt, heat, and normal wear and tear.
- M. Motor starters shall be Eaton Cutler-Hammer A200 Series, Allen-Bradley Bulletin 500 Line, or Square D.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide motor starters for each motor not provided for by others or controlled by starters in motor control centers.
- B. Contractor shall verify all motor horsepower prior to procurement of starters and installation of motor wiring.
- C. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- D. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.
- E. Height: 5 ft. (1.6 M) to operating handle or as indicated on the Drawings.
- F. Install fuses in fusible switches.
- G. Select and install overload heater elements or set solid state overload relays in motor controllers to match installed motor characteristics.
- H. All device settings shall be provided and installed by the device supplier, based on equipment operating and protection requirements. Submit for Owner approval prior to implementation. All as-built settings shall be included in supplied O&M manuals.
- I. Provide engraved plastic nameplates under the provisions of Section 26 05 53 - Electrical Identification.
- J. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- K. NEMA Type 4 and Type 4X enclosures in other than corrosive areas shall be equipped with a combination drain and breather. The drain shall be mounted on a bolt-on, gasketed hub. Combination drain and breather shall be Crouse-Hinds ECD Combination Series, Appleton, or equal.
- L. Arc flash and shock hazard warning labels shall be provided on the door of each contactor and starter enclosure and shall be marked as specified in Section 26 05 53 - Electrical Identification.

3.02 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Sections 01 45 00 - Quality Control and Section 26 08 00 - Calibration and Start-up of Systems.

- B. Inspect and test each enclosed controller to NEMA ICS 2.

END OF SECTION

SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Scope of Work:
 - 1. This Section specifies hangers and supports for all piping systems specified in Division 40.
- B. Qualifications:
 - 1. Piping support systems shall be designed and shop drawings prepared and sealed by a Registered Professional Engineer in the state where the work shall be installed.
- C. Operating Conditions:
 - 1. The hangers and supports specified in this Section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this Section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
 - a. Hot Systems:
 - 1) 120 degrees F to 450 degrees F
 - 2) 451 degrees F to 750 degrees F
 - 2. Over 750 degrees F
 - 3. Ambient Systems:
 - 1) 60 degrees F to 119 degrees F
 - b. Cold Systems:
 - 1) 33 degrees F to 59 degrees F
 - c. -20 degrees F to 32 degrees F
 - 4. Design Requirements:
 - 5. Design, size, and locate piping support systems throughout facility, whether shown or not.
 - 6. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
 - 7. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
 - 8. Meet requirements of MSS SP-58 and ASME B31.1 or as modified by this section.
- D. Hanger and Support Selection:
 - 1. Contractor shall select pipe hangers and supports as specified in the Project Manual. Selections shall be based upon the pipe support classifications specified in this Section and any special requirements which may be specified in the Project Manual.
 - 2. Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of hanger or support to be used at each hanger or support location.
 - 3. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:
 - a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

- b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
 - c. Reaction forces due to the operation of safety or relief valves.
- E. Wind, snow or ice loadings on outdoor piping.
 - a. Seismic loads in accordance with governing codes and as shown on structural general drawings.
- 2. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.
- 3. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.
- 4. Hangers for the suspension of size 2-1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
- 5. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.
- 6. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.
- 7. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.
- 8. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
- 9. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
- 10. Stock hanger and support components shall be used wherever practical.
- 11. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP-58, Table 3 and Table 4.
 - a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
 - b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

1.02 REFERENCE STANDARDS

- A. This Section contains references to the following referenced standards. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Notice to Bidders. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

- C. AISC (MAN): American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
- D. FEDSPEC WW-H-171e-78: Hangers and Supports, Pipe
- E. MFMA-2-91: Metal Framing Standards Publication
- F. MSS SP-69: Pipe Hangers and Supports - Selection and Application
- G. MSS SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger and 4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
 - 2. Calculations for each type of pipe support, attachment and anchor.
 - 3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
- B. Informational Submittals:
 - 1. Maintenance information on piping support system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Grinnell, Erico Caddy, Pipe Shields Incorporated, Superstrut, Unistrut, or approved equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

2.02 MATERIALS

- A. General:
 - 1. Unless detailed otherwise on the drawings, materials for hangers and supports shall be as follows:
 - a. Support materials for process piping, including flushing water, service water 4 inches and larger, dewatering piping, in areas subject to moisture or corrosive atmosphere, shall be manufactured and fabricated of ANSI 316 stainless steel.
 - b. Support materials for all process piping, including flushing water, service water 4 inches and larger, dewatering piping not subject to submergence or corrosive atmospheres shall be galvanized steel, except chemical piping hangers and supports shall be as described above, and piping in finished areas or above suspended ceilings may be galvanized or zinc or cadmium plated.
- B. Pipe, Hangers, and Supports:
 - 1. TYPE 1 - CLEVIS PIPE HANGER: Clevis hangers shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 1.
 - a. Steel pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be B-Line B3100, Grinnell Fig. 260, or approved equal.

- c. Cast and ductile iron pipe - shall be B-Line B3102, Grinnell Fig. 590, or approved equal.
 - d. Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Fig. CT-65, or approved equal.
 - e. Copper pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or approved equal, with insulation shield.
 - f. Plastic pipe - shall be B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or approved equal.
2. TYPE 2 - "J" PIPE HANGER: Hangers shall be carbon steel with configuration and components equivalent to MSS Type 5.
 - a. Steel pipe - shall be B-Line B3690, Grinnell Fig. 67, Erico Caddy model 418, or approved equal.
 3. Copper and plastic pipe - shall be Erico Caddy model 419, Unistrut J 1205N series, or approved equal.
 4. TYPE 3 - DOUBLE BOLT PIPE CLAMP: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 3.
 - a. Steel pipe (insulated) - shall be B-Line B3144, Grinnell Fig. 295, or approved equal, with insulation shield. Insulation shield is optional for hot and ambient systems.
 - b. Steel pipe (uninsulated) - shall be B-Line B3144, Grinnell Fig. 295, or approved equal.
 - c. Copper pipe (insulated only) - shall be B-Line B3144, Grinnell Fig. 295, or approved equal, with insulation shield.
 5. TYPE 4 - ADJUSTABLE ROLLER HANGER: Rollers shall be cast iron, yoke and cross bolt shall be carbon steel. Configuration and components shall be equivalent to MSS Type 43 and FEDSPEC Type 44.
 - a. Steel pipe (insulated) - shall be B-Line B3110, Grinnell Fig. 181, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be B-Line B3110, Grinnell Fig. 181, or approved equal.
 - c. Copper pipe (insulated only) - shall be B-Line B3110, Grinnell Fig. 181, or approved equal, with insulation shield.
 - d. Plastic pipe - shall be B-Line B3110, Grinnell Fig. 181, or approved equal.
 6. TYPE 5 - SINGLE PIPE ROLL: Rollers and sockets shall be cast iron, cross rod shall be steel. Configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.
 - a. Steel pipe (insulated) - shall be B-Line B3114, Grinnell Fig. 171, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be B-Line B3114, Grinnell Fig. 171, or approved equal.
 - c. Plastic pipe - shall be B-Line B3114, Grinnell Fig. 171, or approved equal.
 7. TYPE 6 - FRAMING CHANNEL PIPE CLAMP: Pipe clamps shall be steel with galvanized finish and material thickness as listed below:
 - a. Steel pipe (uninsulated) - Pipe size 3/8 inch and 1/2 inch shall be 16 gage; 3/4 inch through 1 1/4 inches shall be 14 gage; 1 1/2 inches through 3 inches shall be 12 gage; 3 1/2 inches through 5 inches shall be 11 gage; 6 and 8 inches shall be 10

- gage; Erico Caddy model 431, Powerstrut PS 1100, Unistrut P 1109 series, or approved equal.
- b. Steel pipe (insulated) - Pipe clamp shall be as described in this paragraph 6 with insulation shield.
 - c. Copper (uninsulated) and plastic pipe - Pipe size 3/8 inch and 1 inch shall be 16 gage; 1 1/4 inches and 1 1/2 inches shall be 14 gage; 2 inches through 3 inches shall be 12 gage; 4 inches shall be 11 gage; clamp shall be copper-plated, plastic coated or lined with dielectric material; Erico Caddy model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or approved equal.
 - d. Copper pipe (insulated) - Pipe clamp shall be as described in described in this paragraph 6 with insulation shield.
8. TYPE 7 - U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.
- a. Steel pipe (uninsulated) - shall be Grinnell Fig. 137, B-Line B3188, or approved equal.
 - b. Steel pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or approved equal, with insulation shield.
 - c. Cast and ductile iron pipe - shall be Grinnell Fig. 137, B-Line B3188, or approved equal.
 - d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or approved equal.
 - e. Copper pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or approved equal, with insulation shield.
 - f. Plastic pipe - shall be Grinnell Fig. 137C, Erico Caddy model 151, B-Line B3188 C, or approved equal.
9. TYPE 8 - ADJUSTABLE PIPE ROLL SUPPORT: Rollers and sockets shall be cast iron, cross rod and support rods shall be carbon steel.
- a. Steel pipe (insulated) - shall be B-Line B3122, Grinnell Fig. 177, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be B-Line B3122, Grinnell Fig. 177, or approved equal.
 - c. Copper pipe (insulated only) - shall be B-Line B3122, Grinnell Fig. 177, or approved equal, with insulation shield.
 - d. Plastic pipe - shall be B-Line B3122, Grinnell Fig. 177, or approved equal.
 - e. Use of this support should be limited to vertical support applications where approved by the Engineer.
10. TYPE 10 - PIPE STANCHION SADDLE: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.
- a. Steel pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal.
 - c. Cast and ductile iron pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or approved equal.

- d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal, with insulation shield or lined with dielectric material.
 - e. Copper pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal, with insulation shield.
 - f. Plastic pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal.
11. TYPE 11 - OFFSET PIPE CLAMP: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.
- a. Steel pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or approved equal, with insulation shield.
 - b. Steel pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or approved equal.
12. Cast and ductile iron pipe - shall be B-Line B3148 NS, Grinnell Fig. 103, or approved equal.
- a. Copper pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or approved equal, with insulation shield.
 - b. Copper pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or approved equal, lined with dielectric material.
 - c. Plastic pipe - shall be B-Line B3148, Grinnell Fig. 103, or approved equal.
 - d. Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.
13. TYPE 12 - RISER CLAMP: Riser clamp shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 8.
- a. Steel pipe (insulated) - shall be B-Line B3373, Grinnell Fig. 261, or approved equal.
 - b. Steel pipe (uninsulated) - shall be B-Line B3373, Grinnell Fig. 261, or approved equal.
 - c. Cast and ductile iron pipe - shall be B-Line B3373, Grinnell Fig. 261, or approved equal.
 - d. Copper pipe (insulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or approved equal.
 - e. Copper pipe (uninsulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Erico Caddy model 511, or approved equal.
 - f. Plastic pipe - shall be B-Line B3373, Grinnell Fig. 261c, or approved equal.
14. TYPE 13 - FRAMING CHANNEL PIPE STRAP: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.
- a. Steel pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or approved equal.
 - b. Steel pipe (insulated) - shall be Superstrut No. C 708-U, Powerstrut PS 3126, Kin-Line No. 477, or approved equal, with insulation shield.
 - c. Copper pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, or approved equal, with insulation shield or lined with dielectric material.
 - d. Copper pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, or approved equal, with insulation shield.

- e. Plastic pipe - shall be Superstrut No. C-708-U, Powerstrut PS 3126, or approved equal.

C. Rack and Trapeze Supports:

1. General: Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.
2. TYPE 20 - TRAPEZE PIPE SUPPORT: Trapeze pipe support cross members shall be framing channel as specified in this Section. Flat plate fittings shall be 1 5/8-inch square carbon steel of standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or approved equal.
3. TYPE 21 - PIPE RACK SUPPORT: Post and cross members shall be framing channel as specified in Article 2.2.E.5 of this section. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer. 90 degree fittings shall be gusseted Unistrut P2484, B-Line B844, or approved equal. Post base fittings shall be as specified in this section.

D. Structural Attachments:

1. TYPE A - MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or approved equal.
2. TYPE B - SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or approved equal.
3. TYPE C - MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or approved equal.
4. TYPE D - STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or approved equal.
5. TYPE E - FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer.
 - a. Single channel: Unistrut P2072A, B-Line B280, or approved equal.
 - b. Double channel: Unistrut P2073A, B-Line B281, or approved equal.
6. TYPE F - WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or approved equal.
7. TYPE G - WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.
8. TYPE H - CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or approved equal.
9. TYPE J - ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or approved equal.
10. TYPE K - DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in this Section. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or approved equal.

11. TYPE L - SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in Article 2.2.E.5 of this section. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or approved equal.
 12. TYPE M - WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in Article 2.2.E.5 of this section.
 13. TYPE N - PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.
- E. Accessories:
1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
 2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or approved equal.
 3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or approved equal.
 4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or approved equal.
 5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges.
 - a. Single channel: Unistrut P1000, B-Line B22, or approved equal.
 - b. Double channel: Unistrut P1001, B-Line B22A, or approved equal.
 - c. Triple channel: Unistrut P1004A, B-Line B22X, or approved equal.

2.03 THERMAL PIPE HANGER SHIELD

- A. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.
- B. Standard Shield:
- a. Insulation:
 - 1) Hydrous calcium silicate, high density, waterproof.
 - 2) Compressive strength: 100 psi average.
 - 3) Flexural strength: 75 psi average.
 - 4) K factor: 0.38 at 100 degrees F mean.
 - 5) Temperature range: 20 degrees F to 500 degrees F.
 - b. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

- c. Connection: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.
- 2. Vapor Barrier Shield:
 - a. Insulation:
 - 1) Hydrous calcium silicate, high density, waterproof.
 - 2) Compressive strength: 100 psi average.
 - 3) Flexural strength: 75 psi average.
 - 4) K factor: 0.38 at 100 degrees F mean.
 - 5) Temperature range: 20 degrees F to 500 degrees F.
 - b. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
 - c. Connection: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor-tight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

- A. Hanger and support locations and components shall be indicated on the piping layout shop drawings.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

- A. Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.
- B. At least one hanger or support shall be located within 2 feet from a pipe change in direction.
- C. Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.
- D. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.
- E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

- A. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.
- B. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.
- C. Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.
- D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

- E. Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.
- F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.
- G. Rollers shall roll freely without binding.
- H. Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.
- I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.
- J. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

- A. Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 FIELD FINISHING

- A. Paint atmospheric exposed surfaces of galvanized steel components as specified in Section 09 96 00 - Industrial Paints and Coatings.

END OF SECTION

SECTION 40 05 52 PROCESS VALVES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Butterfly valves - metal body.
- B. Knife gate valves
- C. Valve operators.
- D. Electric valve operators.

1.02 REFERENCE STANDARDS

- A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- B. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications 2023.
- E. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications 2022b.
- F. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- G. AWWA C504 - Rubber-Seated Butterfly Valves 2015.
- H. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.
- I. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions 2018, with Errata (2023).
- J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures for submittal procedures.
- B. Product Data: Manufacturer's data sheets for each valve and accessory, showing compliance with requirements; include materials, pressure ratings, valve operators, seats and seals, clearances for operation and maintenance, and other characteristics.
 - 1. Identify data sheets using the valve identification scheme used on drawings.
 - 2. For electric actuators, show electrical characteristics.
- C. Shop Drawings: Custom-prepared piping diagrams showing location of each valve and drain, whether or not indicated in Contract Documents; this shop drawing may be combined with other piping shop drawings.
- D. Valve Schedule: Custom-prepared schedule of valves, showing:
 - 1. Valve identifying number; cross-reference to product data sheets and to process and instrumentation diagrams (P&ID).
 - 2. Manufacturer and model name/number.
 - 3. Valve type using specification terminology (e.g. gate, metal body, over 2 inch).
 - 4. Application (direct-buried or exposed).
 - 5. Piping Service (e.g. return activated sludge).

6. Installation orientation (horizontal or vertical pipe, stem vertical or horizontal).
 7. Size and dimensions.
 8. Flow coefficient Kv.
 9. Pressure rating and pressure drop at specified flow rate.
 10. Spring range.
 11. Valve end type (e.g., flanged, threaded, socket-welded).
 12. Manual operator type.
 13. Automatic operator type, where applicable, and identifying number.
 14. Accessories (e.g., extension stem, floor stand, extension bonnet).
 15. Access and clearance requirements.
- E. Automatic Operator Schedule: Custom-prepared schedule of automatic valve operators, showing:
1. Valve and operator identifying numbers.
 2. Operator manufacturer and model number.
 3. Positive positioner range.
 4. Close-off pressure to torque.
 5. Electric Actuators: Input and output contacts.
 6. Access and clearance requirements.
- F. Automatic Valve Operator Calculations: For each remote-controlled valve, submit calculations supporting selection of actuator, including calculations of the force required to move and seal the valve.
- G. Operating and Maintenance Data.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.05 WARRANTY

- A. See Section 01 77 00 - Closeout Procedures for additional warranty requirements.

PART 2 PRODUCTS

2.01 VALVE APPLICATIONS

- A. Do not direct-bury flanged valves; provide valve pit or manhole.

2.02 REQUIREMENTS APPLICABLE TO ALL VALVES

- A. See drawings for valve sizes, valve ratings, operator types, and piping types and sizes.
- B. Provide valves suitable for the service indicated and coordinated to piping system.
1. Provide valves that will withstand working pressure indicated or working pressure of pipe to which valve is connected, whichever is greater.
 2. Provide valves of sizes indicated or of port diameter/area equal to that of pipe to which valve is connected, whichever is larger.
 3. Provide valves that open by turning counterclockwise, with direction of opening integrally marked on operating nut or operator.

4. Valve End Connections: As indicated; if not indicated, provide end connections of the same type as indicated for joints in pipe to which valve is connected.
 5. Factory install operators and accessories.
- C. Identification and Tagging: In addition to the information required by Section 46 05 00, mark valves in accordance with MSS SP-25 using identification tags securely attached; on tags show the service, valve identification number from drawings, manufacturer's name and model number.
1. Identification Tags: 1.375 inches diameter, minimum; engraved laminated plastic with black lettering.
 2. Attachment: No. 12 AWG copper wire.

2.03 REQUIREMENTS APPLICABLE TO METAL-BODY VALVES

- A. Valve End Connections:
1. Flanged Ends: In accordance with ASME B16.5; Class 125 pound unless otherwise indicated.
- B. Valve Exterior Finish: Factory-applied epoxy coating complying with AWWA C550; either two-part liquid material or heat-activated material.
1. Where valve is indicated to have fusion bonded epoxy finish, provide only heat-activated material.
 2. Coating Thickness: 7 mils, minimum, dry film thickness.
 3. Colors: As specified in Section 46 05 00; use "safety yellow" for isolation valves and lockout valves with handles, hand wheels, or chain wheels.
- C. Valve Lining: Where valves are indicated to be lined, provide factory-applied factory-applied lining; use epoxy lining unless other material is indicated.
1. Epoxy Lining: AWWA C550; either two-part liquid material or heat-activated material except provide only heat-activated material when lining is indicated as fusion bonded.
 2. Epoxy Lining Thickness: 7 mils, minimum, dry film thickness, except where thickness is limited by valve operating tolerances.

2.04 BUTTERFLY VALVES - METAL BODY

- A. Manufacturers:
1. Dezurik.
 2. ValMatic
 3. Crispin
 4. Pratt
- B. Butterfly Valves: flanged style.
1. AWWA Class: 150 in accordance with AWWA C504.
 2. Body: ASTM A126 cast iron.
 3. Disc: Contoured ASTM A436 Type 1 Ni-resist cast iron with maximum lead content of 0.003 percent.
 4. Valve Shafts: Carbon steel with self-lubricating, corrosion-resistant sleeve type bearings.
 5. Seats for Valves 24 inch and Smaller: Attached to either valve body or disc; chloroprene.
 6. Seats for Valves Larger Than 30 inch: Field replaceable.

7. End Connections: Flanged.

2.05 KNIFE GATE VALVES

- A. Manufacturers:
 1. Dezurik / Hilton.
 2. Mueller / Pratt.
 3. ITT
- B. Knife Gate Valves: Bonnetless metal seat type with clear waterway equal to full diameter of valve meeting AWWA C520, MSS SP-81.
 1. Rating: 150 psig.
 2. Body: Cast 304 SS.
 3. Seat: Integral with body, fully machined finish, with gate guides and jams capable of full reverse pressure.
 4. Disc: 304 SS with fully machined face and beveled leading edge.
 5. Packing System: Machined packing chamber with anti-extrusion ring.
 - a. Packing Gland: 304 SS.
 - b. Packing: PTFE braided packing.
 - c. Bolts, nuts, & washers: 304 SS.
 6. End Connections: Lugged, drilled and tapped to ANSI B16.5, Class150 pound standard with raised faces.
 7. Yoke: Cast steel.
 8. Stem: 304 SS with Acme threads.
 9. Stem Nut: Aluminum Bronze.
 10. Manual Operator: Hand wheel, valves 16" and large bevel gear operators

2.06 VALVE OPERATORS

- A. Operator Types:
 1. For each valve controlled by process control system, provide remote-controlled automatic operator, electric type.
 2. For each valve not controlled by process control system, provide a manual operator, except for self-actuated valves.
- B. Operators: Sized to operate valve for full range of pressures and velocities and of the type specified for application:
 1. Maximum Force to Operate: Not more than 39.3 pounds-force under any operating condition including initial breakaway; provide gear reduction where necessary to reduce force to operate.
 2. Locking: Self-locking or equipped with self-locking device; padlock eyes on valve handles; wheels lockable with chain and padlock.
 3. Quarter Turn Valves: Provide position indicator.
- C. Automatic Operators: Actuator, valve stem coupling, gearing if required, size and configuration to suit full range of valve operation, and additional requirements as indicated.
 1. Totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator.

2. For Quarter Turn Valves: Reversing, bi-directional operation.
 3. Provide manual override mechanism unless specifically indicated as "no manual override"; with lockable motor de-clutch mechanism.
 4. On loss of control signal, maintain valve in last position, unless otherwise indicated.
 5. Housing: NEMA 250 Type 4X enclosure.
- D. Manual Operators:
1. Exposed Valves: Hand wheel type operator except where other type is permitted or required.
 2. Hand Wheels: Galvanized and painted.
 3. Lever handles are allowed on quarter-turn valves 8 inches and smaller.

2.07 ELECTRIC VALVE OPERATORS

- A. Manufacturers:
1. Rotork.
- B. Electric Operators: Motor-operated.
1. Gearing: Two-stage, planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output shaft.
 2. Start-up Torque: 120 foot-pound.
 3. Stall Torque: 150 foot-pound.
 4. Duty Cycle: 75 percent.
 5. Equipped with AC thermal overload protector with automatic reset or non-overloading under normal operating conditions.
- C. Positioners: For modulating actuators provide positioner controlling the valve position as function of input signals; direct acting; with corrosion-resistant, splash- and moisture-proof enclosure with gasketed cover.
1. Voltage: 120 volts AC, 60 Hz.
 2. Input Signals: 4 to 20 mA unless otherwise indicated.
- D. Limit Switches: Travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams mounted on drive shaft.
1. Single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts AC.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install valves as nearly as possible in position indicated on drawings, located and oriented to provide easy access to valve operator and to avoid interference with other equipment.
- C. Install valves without exerting distortion or strain on appurtenances.
- D. Flanged Connections:
1. Install flanged valve bolt holes so as to straddle vertical centerline of pipe.
 2. Clean flanged faces prior to inserting gasket and bolts.
 3. Tighten nuts progressively and uniformly.
- E. Threaded Connections: Clean threads by wire brushing or swabbing prior to installation.

- F. Manual Valve Orientation in Horizontal Runs of Pipe:
 - 1. Where pipe centerline elevation is 54 inches or less above finished floor, install valve with operating stem of in vertical position, unless otherwise indicated.
 - 2. Where pipe centerline elevation is between 54 inches and 81 inches above finish floor, install valve with stem in horizontal position, unless otherwise indicated.
- G. Automatic Valves: Install in accordance with manufacturer's instructions.
- H. Butterfly Valves: Orient valve shafts so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of disc.

3.02 FIELD QUALITY CONTROL - PRIOR TO STARTUP

- A. Demonstrate proper valve operation while testing pipelines or as a separate step.
 - 1. Show that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.
 - 2. Count and record the number of turns required to open and close each valve, and account for any discrepancies from manufacturer's data.
- B. Isolation Valve Leak Check:
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- C. Actuator Range Check: Verify proper operation of actuators and positioners.
 - 1. Verify that actuator extreme positions are correct.
 - 2. Apply a signal to actuator through its controller.
 - 3. Record the signal levels for the extreme positions.
 - 4. Vary the signal over its full range and verify that actuators travel in the correct direction and from one extreme position to the other.
- D. Valve Stroke Setup and Check:
 - 1. Verify the actual positions against the control system readout.
 - 2. Set pump to normal operating mode.
 - 3. Command valve closed; visually verify that valve is closed and adjust output zero signal as required.
 - 4. Command valve to open; verify position is full open and adjust output signal as required.
 - 5. Command valve to a few intermediate positions.
 - 6. If actual valve position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

END OF SECTION

SECTION 40 20 00 LIQUID PROCESS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flanged ductile iron pipe and fittings.
- B. Carbon steel pipe and fittings.

1.02 RELATED REQUIREMENTS

- A. See drawings for normal service conditions, pipe sizes, pressure ratings, nominal wall thicknesses, and insulation requirements.
- B. Section 46 01 06 - Operation and Maintenance Manual.
- C. Section 46 05 00 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all piping and equipment.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- C. ASME B16.9 - Factory-Made Wrought Butt welding Fittings 2018.
- D. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded 2021.
- E. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges 2021.
- F. ASME B31.3 - Process Piping 2022.
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- H. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications 2023.
- I. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service 2019a.
- J. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications 2023.
- K. ASTM A194/A194M - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both 2022a.
- L. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- M. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- N. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).
- O. ASTM A513/A513M - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing 2020a.
- P. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes 2018.
- Q. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015 (Reapproved 2021).

- R. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings 2022.
- S. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 2021.
- T. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.
- U. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2020.
- V. AWWA C606 - Grooved and Shouldered Joints 2022.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, and Section 46 05 00 for submittal procedures.
- B. Product Data: Manufacturer's descriptive and technical literature for each material and component, showing compliance with requirements and installation instructions.
- C. Shop Drawings:
 - 1. List of piping systems, indicating application, material, size, and pressure rating.
 - 2. Detailed drawings of piping systems, showing locations of valves, expansion joints, specialties, and instrument connections.
- D. Waste Water Disposal: Before starting operations that require a temporary water supply submit the method proposed for disposal of waste water; for information; where regulatory permits are required, submit evidence that permits have been obtained.
- E. Pipe Testing Plan.
- F. Field Quality Control Reports.
- G. Operation and Maintenance Data: See Section 46 01 06.
- H. Project Record Documents: Record actual locations of pipe anchors and guides and layout of piping systems relative to other parts of the work including clearances for maintenance and operation.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS - GENERAL REQUIREMENTS

- A. Piping and Fittings: New and unused material.
 - 1. Pressure Ratings: As indicated on drawings.
 - 2. Nominal Sizes: As indicated on drawings.
 - 3. Fittings: Same pressure rating as pipe, or greater, unless higher rating is specified; same material as pipe unless otherwise indicated.
 - 4. Sizes: Use standardized nominal sizes for compatibility with future work.
 - 5. Material Identification: Permanently mark each piece of pipe and fitting with its AWWA or ASTM designation and other markings required for that designation.
- B. Joints: Completed joints are to have working pressure rating for liquids equal to pressure rating of the pipe.
- C. Flanged Joints and Fittings (Metal and Plastic): Internal diameter bores of flanges and flanged fittings same as that of pipe.
 - 1. Bolting: Hex head bolts of alloy-steel complying with ASTM A193/A193M Grade B5, hex head nuts of ASTM A194/A194M, and washers of same material as bolts; except when mating with cast iron flanges use Grade B8 Class 1 bolts and Grade 8 heavy hex head nuts.

2. Provide with washers of same material as bolts.
3. Non-Metallic Gaskets: Chloroprene rubber, unless otherwise indicated; ASME B16.5 and ASME B16.21.
 - a. Thickness: 1/8 inch, maximum.
 - b. Hardness: 80 Shore A durometer, in accordance with ASTM D2240.
 - c. Tensile Strength: 1,500 psi, minimum.
 - d. Elongation: 125 percent, minimum.
 - e. For Raised Face Flanges: Flat ring type.
 - f. For Flat Face Flanges: Full face type.
- D. Bolts and Nuts:
 1. Non-Submerged: Zinc-plated; on cast iron and ductile iron couplings high-strength, low-alloy steel complying with AWWA C111/A21.11.
 2. Buried and Submerged: Stainless steel, TP304.
- E. Isolation Devices for Dissimilar Metals: Where dissimilar metallic piping, fittings, or valves must be connected, use isolation devices as indicated and as required to separate the different materials to avoid galvanic action.
 1. For flanged connections use flange isolation gaskets; gas-tight where underground.
 2. For threaded and welded connections, use dielectric fittings.
 3. For mechanical joints, use joint devices that accomplish separation.
- F. Pipe Closure Pieces: ASME B16.9 or ASME B16.11; provide wherever pipe runs end.
- G. External Coatings: Unless otherwise indicated; finish fittings with same coating as pipe.

2.02 FLANGED DUCTILE IRON PIPE FOR PRESSURE SERVICE

- A. Ductile-Iron Pipe: AWWA C115/A21.15, all pipe sizes, with ASME B16.1, Class 125 flanges.
 1. Cement-Mortar-Lining: AWWA C104/A21.4 standard thickness cement lining with tolerance of plus 1/8 inch permitted.
 2. External Coating: Coated on outside with manufacturer's standard asphaltic coating, approximately one mil thick.
 3. Joints: Comply with AWWA C110/A21.10.
 - a. Provide gaskets, glands, bolts and nuts as required to completely assemble joints.
 - b. Gaskets: Vulcanized synthetic rubber; reclaimed rubber is not acceptable.
- B. Fittings: Ductile iron or gray iron, cement mortar lined same as pipe.
 1. Pipe Diameters Up To 12 inches Inclusive: Use fittings rated 250 psig.
 2. 150 psi Service: AWWA C110/A21.10.
 3. Bolts and Nuts: Carbon steel complying with ASTM A307, Grade B, with washers of same material.
 4. Gaskets: Full face.

2.03 CARBON STEEL PIPE

- A. Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
 1. Welded:

- a. 2-1/2" thru 10": Schedule 40.
 - b. 12" thru 16": Schedule 30.
 - c. 18" thru 24": Schedule 20.
 - d. 2-1/2" thru 6": Schedule 40.
 - e. 8" thru 12": Schedule 30.
 - f. 14": Standard weight.
- B. Joints:
 - 1. 2 1/2" & larger: Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
- C. Fittings:
 - 1. 2 1/2" & larger:
 - a. Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M A, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
- D. Branch Connections:
 - 1. 2 1/2" & larger: Butt-welding or grooved end tee in conformance with Fittings specified above.
- E. Flanges:
 - 1. 2 1/2" & larger:
 - a. Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16 inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.
 - b. Cast Iron Mating Flange: ASTM C207, Class D or E, hub or ring type to mate with ASME B16.1 Class 125 cast-iron flange. ASTM C207 Class F hub type or ASTM A105/A105M, ASME B16.5 Class 300 to mate with ASME B16.1 Class 250 cast-iron flange.

2.04 JOINING DEVICES FOR METAL PIPE

- A. Couplings for Joining Plain End Pipe Sections: Sleeve-type, comprised of cylindrical sleeve, two end bolting rings, two gaskets, and connecting bolts; sized to match piping.
 - 1. Pipe Sizes 1/2 through 1-1/2 inch: End rings of ductile iron; sleeve of ASTM A513/A513M; standard weight pattern.
 - 2. Pipe Sizes 2 inches and Larger: End rings of ASTM A395/A395M; sleeve of ASTM A513/A513M; standard weight pattern.
 - 3. Steel Components: Fusion bonded epoxy-lined and coated.
 - 4. Couplings Made with Steel Components: Pressure tested beyond yield point.
 - 5. Bolting Dimensions: AWWA C111/A21.11.
 - 6. Bolts: Elliptic-neck, track-head steel bolts designed to properly compress gaskets.
 - 7. Gaskets: Wedge type; natural rubber.
 - 8. Transition couplings may be used to connect two pipes of same material that have small differences in outside diameter.
 - 9. Manufacturers:

- a. Dresser Piping Specialties.
- b. Smith-Blair, Inc.
- c. Romac.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that size and location of piping, sleeves, and appurtenances embedded in concrete are correct.

3.02 PREPARATION

- A. Keep Interior of Pipes Clean:
 - 1. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material inside piping sections during fabrication.
 - 2. Close pipe openings with caps or plugs before, during, and after installation.
 - 3. Remove foreign objects and dirt prior to assembly and installation.
- B. Protect pipe coatings from chemical and mechanical damage; do not install damaged products.
- C. Repair damaged zinc, organic, and paint coatings with material equal to original coating, as specified in Section 46 05 00.
- D. Before field fabrication of pipe or fittings, notify Engineer at least 2 weeks prior to date of starting fabrication.
- E. Before field coating of pipe or fittings, notify Engineer at least 3 days prior to date of starting any surface preparation or coating work.

3.03 INSTALLATION - GENERAL

- A. Install piping and appurtenances in compliance with ASME B31.3, reviewed shop drawings, if any, and manufacturer's instructions, with all joints tight and no undue marring of finishes.
 - 1. Install piping to accurate lines and grades.
 - 2. Run piping as straight as practical in alignment shown with minimum of joints.
 - 3. Maintain required upstream and downstream clearances.
 - 4. At flow measuring devices, provide straight runs of piping upstream and downstream as indicated.
 - 5. Install piping without springing or forcing pipe to fit.
 - 6. Pitch piping toward low points and provide a valved drain at each low point.
 - 7. Provide a sufficient number of unions or flanges to allow for dismantling of pipe, valves, and equipment.
 - 8. Where temporary supports are used, make them sufficiently rigid to prevent shifting or distortion of pipe.
 - 9. Make installed piping, valves, and fittings free from strain and excessive stresses caused by weight or misalignment.
- B. Provide isolation valves and miscellaneous devices as required for an operable installation.
- C. Pipe Jointing: Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after installation.

- D. Thermal Expansion and Contraction: Install piping to allow for thermal expansion and contraction resulting from difference between temperature during installation and during operation.
 - 1. Anchors: Locate as indicated on drawings and reviewed shop drawings, if any, to withstand expansion thrust loads and to direct and control thermal expansion.
 - 2. Intermediate Pipe Alignment Guides:
 - a. Install adjacent to pipe expansion joints and within four pipe diameters each side.
 - b. At pipe mounted on metal channel framing, install intermediate pipe guide at each metal channel framing support not carrying an anchor or alignment guide.
- E. Pipe Tap Connections: Taps direct to pipe barrels are prohibited; make taps as follows:

3.04 METALLIC PIPE JOINTING

- A. Connecting Dissimilar Metallic Pipe and Appurtenances: Use isolation devices as specified and as required to separate different materials to avoid galvanic action; install in accordance with manufacturer's instructions.
- B. Flanged Joints: Make flanged joints up tight, taking care to avoid undue strain on flanges.
 - 1. Install flanged fittings true and perpendicular to axis of pipe.
 - 2. Install so that adjoining flange faces are not out of parallel to such degree that joint cannot be made watertight without overstraining flanges.
 - 3. Align bolt holes in both flanges; use full size bolts; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose is not permitted.
 - 4. Where instrumentation device is indicated to be installed in the vertical centerline of pipe, install flanges with bolt holes straddling vertical centerline of pipe.
 - 5. Tighten bolts uniformly to prevent overstressing flanges and misalignment.
 - 6. Replace flanged pipe and fittings whose dimensions do not allow making flanged joint as specified.

3.05 FIELD QUALITY CONTROL - GENERAL

- A. Test all parts of piping systems using clean water and hydrostatic pressure and leakage tests, unless otherwise indicated.
- B. Leakage Testing: Perform after pressure tests have been satisfactorily completed, unless otherwise approved by Owner.
- C. Water: Provide clean test water of such quality to avoid corrosion of piping system materials.

3.06 FIELD QUALITY CONTROL - HYDROSTATIC PRESSURE TESTING

- A. Perform hydrostatic testing in accordance with ASME B31.3 under normal service conditions.
- B. Maximum Velocity During Filling: 0.25 fps applied over full area of pipe or as recommended by pipe manufacturer, whichever is lesser.
- C. Venting Air While Filling: Purge all air in system; open air release vents to purge air pockets; venting may also be provided by loosening minimum of four bolts of flanges or by use of equipment vents.
- D. Valves: Include each valve in at least one piping section tested; open and close valves several times during test.
- E. Rigid Piping Test Procedure:
 - 1. Maintain test pressure continuously for minimum of 30 minutes and during examinations for leakage.

2. Leave piping system full of water after leaks are repaired, unless otherwise directed by Owner.
- F. Non-Rigid, Non-Metallic Piping and Metallic Piping With Non-Metallic Liner Test Procedure:
1. Raise pressure to 50 percent of normal service pressure.
 2. Inspect pipe, fittings, joints and connections, and valves for visible leakage; correct leaks and continue test.
 3. Raise pressure to test pressure and add small amounts of test liquid as required hourly for maximum of 3 hours as required to maintain test pressure.
 4. After 4 hours, lower test pressure by 10.2 psi.
 5. If pressure remains steady for one (1) hour, no leakage is indicated.
 6. Before retesting, allow piping system to relax for 8 hours.
- G. Inspect pipe, fittings, joints and connections, and valves for visible leakage; correct leaks and re-test until results are satisfactory.

3.07 FIELD QUALITY CONTROL - PIPE LEAKAGE TESTING

- A. Test piping for leakage by filling with water, or other appropriate test liquid, applying specified test pressure, and measuring amount of additional liquid is necessary to maintain the specified pressure for the specified duration.
- B. Duration of Leakage Test: At least 2 hours after piping has been filled and air has been expelled.
- C. Test Pressure: 200 psig plus/minus 5 psig.
- D. Locate leaks, repair, and re-test until leakage is within specified limits.

3.08 CLEANING PIPING - PRIOR TO STARTUP

- A. After testing, flush piping with water to remove accumulated construction debris and other foreign matter; continue flushing until no foreign matter exits the pipe.
- B. Install cone strainers in connections of attached equipment and leave in place until flushing is completed. Remove accumulated debris through drains or by removing spools or valves.
- C. Minimum Flushing Velocity: 2.5 feet per second.
- D. For large diameter pipe impractical to flush at minimum flushing velocity, clean pipe in place from inside by brushing and sweeping, then flush at a lower velocity.

END OF SECTION

SECTION 40 71 13 MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section describes the requirements for field-mount flow measuring and sensing Instruments, and associated devices and appurtenances. Under this Section, the Contractor shall furnish and install the specified equipment and accessories as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 10 - Basic Electrical Materials and Methods
- B. Section 26 05 53 - Electrical Identification
- C. Section 26 07 05 - Electrical Testing and Equipment
- D. Section 26 07 10 - Demonstration and Training
- E. Section 26 09 00 - Instrumentation and Control for Electrical Systems - General

1.03 REGULATORY REQUIREMENTS AND REFERENCES

- A. Conform to requirements of NFPA 70 National Electrical Code.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, as acceptable to the authority having jurisdiction, and as suitable for purpose Specified, and as indicated on the Drawings.
- C. Equipment and workmanship shall be in conformance with all applicable standards and requirements of any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
- D. Products shall meet the latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories, including, but not limited to:
 - 1. ANSI/ISA applicable standards for measurement and instrumentation.
 - 2. NEMA ICS 1 - General Standards for Industrial Control Systems, NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies, and NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings as required in Sections 01 33 00.
 - 2. Shop Drawings shall indicate electrical characteristics and connection requirements, including layout of complete assemblies, interconnecting cabling, dimensions, weights, and external power requirements for each Product supplied. Provide Product Data showing manufacturer's specifications, electrical characteristics, and connection requirements for each Product supplied.
 - 3. Include Application and Installation Instructions indicating all conditions and limitations of use stipulated by the manufacturer, and/or Product Testing Agency, and any instructions for storage, handling, protection, examination, preparation, installation, and starting for each Product supplied.
- B. Operation and Maintenance Data:

1. Installation and Start-Up Requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.
 2. Maintenance Data shall include component parts diagrams and Lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.
- C. Recording Drawings:
1. Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Handling:
1. Materials and equipment shall be delivered, unloaded, and handled in a manner to protect against damage. Contractor shall repair or replace all damaged or defective material at Engineer's option and at no cost to Owner or Engineer.
 2. Storage:
 - a. Store materials in enclosures or under protective coverings. Keep inside of pipe fittings and valves free of dirt and debris. Store in a manner for easy identification of all materials.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.07 PROJECT CONDITIONS

- A. Instruments shall be provided in enclosures, or housings, suitable for the environment of the intended installed location, as shown on the Drawings, and as described hereinbelow. Manufacturer shall provide integral heater(s) and/or cooler(s) where required for proper operation under normally expected conditions. Normal ambient temperatures at the facility site range from minus 30 to plus 45 degrees Celsius (minus 25 to plus 115 degrees Fahrenheit). Instruments in outdoor locations shall be suitable for operation under these conditions, while in direct sunlight, or under windy conditions with associated "chill" factors.
- B. Maintain instruments free of dirt and dust during and after installation.

1.08 WARRANTY

- A. The manufacturer shall warrant the meter(s) to be free from defects in materials and workmanship for one (1) year after installation.

1.09 SYSTEM DESCRIPTION

- A. Electromagnetic flow meter is intended for fluid metering in potable water. No moving parts are in the flow stream. Transmitter will be remote-mounted. Unit will be ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit will provide pulse signals that can be fed to dedicated batch controllers, PLCs and other specified specialized instrumentation.

PART 2 PRODUCTS

2.01 MAGNETIC FLOWMETER SYSTEMS (FE/FTI)

- A. Magnetic Flowmeters shall be as manufactured by ABB, Krohne, Rosemount, Endress & Hauser, Siemens or Badger Meter.

- B. Each magnetic flowmeter system shall consist of a magnetic flowmeter (FE) and a flow transmitter indicator (FTI). The size of the meters and flow ranges shall be as shown on the Drawings.
- C. Each magnetic flowmeter shall be of the DC type and shall be equipped with: tungsten carbide, stainless steel or platinum electrodes; copper magnetic coils; a lined stainless steel flow tube, with welded steel housing, and with ANSI Class 150 flanges on both ends; two metallic liner protectors, which shall serve as grounding rings; and, two ground straps. A wafer style body to mount between two ANSI Class 150 flanges and the two grounding rings shall be allowed for meters smaller than 6" in size.
- D. The flow tube liner shall be neoprene or polyurethane for wastewater or sludge streams; and, of PTFE for chemical streams. The electrodes and liner protectors shall be of material suitable for use with the liquid stream being measured.
- E. The flow transmitter shall accept the millivolt signal from the magnetic flowmeter and convert the signal into a 4-20 ma linear flow signal as well as a scaled pulse output. Accuracy shall be +/- 0.5% of rate of flow from 1FPS to 32FPS. The signal converter shall: be microprocessor based; have adjustable damping up to 90 sec/full scale response to 100% step change; provide full isolation of I/O; and maintain continuous zero stability.
- F. The flow transmitter shall operate at 120 VAC and be housed in a remote mounted waterproof and splashproof enclosure for protection of electronic parts. A flow indicator calibrated in GPM, or other engineering units, as shown on the Drawings, shall also be provided.
- G. If a flow indicator is not available integral to the flow transmitter, a remote flow indicator shall be provided as specified.
- H. Magnetic flowmeters installed in below-grade locations shall be suitable for occasional submergence: 30 feet for 72 hours (minimum). All necessary appurtenances (sealing fittings) for the field installation to meet this submergence requirement shall be included with the meter.

2.02 CALIBRATION

- A. Each flow sensor, and each flow transmitter/indicator, shall be provided with a certified calibration traceable to NIST.
- B. A copy of the manufacturer's configuration software and any necessary cables shall be provided to the Owner, for use in calibrating the flow transmitter instruments. If software is not available, then two (2) handheld configurators shall be provided to the Owner.

PART 3 EXECUTION

3.01 VERIFICATION

- A. Contractor shall field measure all dimensions and check possible interferences for the meter(s) and specified accessories.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make all instrumentation interconnections (process, electrical, etc.) as indicated and required for proper operation and intended use.
- D. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, and wire marker, etc. requirements.

3.03 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 07 05 - Electrical Testing and Equipment.

- B. Perform operational testing on instrumentation and control systems to verify proper operation and field wiring connections.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Prepare, calibrate, and start systems under provisions of Section 26 08 00 - Calibration and Start-up of Systems.
- B. Calibrate and/or verify each device for the zeros, ranges, and spans indicated on the Drawings.

3.05 DEMONSTRATION

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 07 10 - Demonstration and Training.
- C. After acceptance of the flow instrument equipment, the Owner's operators shall be provided with one-half day (minimum) of onsite training in the use and maintenance of each type of the equipment. The training shall cover the calibration of the flow instruments, preventative maintenance of all equipment, and troubleshooting and repair/replacement procedures.

3.06 SPARES

- A. In addition to the installed equipment, as Specified above, and as shown on the Drawings, provide one spare of each type of transmitter-indicator, and one spare of each type of flow switch, each package, as indicated.
- B. Turn over software, and all spares at the time of, and as a condition of, acceptance.

END OF SECTION

SECTION 40 72 00 LEVEL MEASUREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section describes the requirements for field-mount leveling measuring and sensing instruments, and associated devices and appurtenances. Under this Section, the Contractor shall furnish and install the specified equipment and accessories as indicated on the Plans and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 10 - Basic Electrical Materials and Methods
- B. Section 26 05 53 - Electrical Identification
- C. Section 26 07 05 - Electrical Testing and Equipment
- D. Section 26 07 10 - Demonstration and Training
- E. Section 26 09 00 - Instrumentation and Control for Electrical Systems - General

1.03 REGULATORY REQUIREMENTS AND REFERENCES

- A. Conform to requirements of NFPA 70 National Electrical Code.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, as acceptable to the authority having jurisdiction, and as suitable for purpose Specified, and as indicated on the Drawings.
- C. Equipment and workmanship shall be in conformance with all applicable standards and requirements of any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
- D. Products shall meet the latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories, including, but not limited to:
 - 1. ANSI/ISA applicable standards for measurement and instrumentation.
 - 2. NEMA ICS 1 - General Standards for Industrial Control Systems, NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies, and NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings as required in Sections 01 33 00.
 - 2. Shop Drawings shall indicate electrical characteristics and connection requirements, including layout of complete assemblies, interconnecting cabling, dimensions, weights, and external power requirements for each Product supplied. Provide Product Data showing manufacturer's specifications, electrical characteristics, and connection requirements for each Product supplied.
 - 3. Include Application and Installation Instructions indicating all conditions and limitations of use stipulated by the manufacturer, and/or Product Testing Agency, and any instructions for storage, handling, protection, examination, preparation, installation, and starting for each Product supplied.
- B. Operation and Maintenance Data:

1. Installation and Start-Up Requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.
 2. Maintenance Data shall include component parts diagrams and Lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.
- C. Recording Drawings:
1. Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Handling:
1. Materials and equipment shall be delivered, unloaded, and handled in a manner to protect against damage. Contractor shall repair or replace all damaged or defective material at Engineer's option and at no cost to Owner or Engineer.
 2. Storage:
 - a. Store materials in enclosures or under protective coverings. Keep inside of pipe fittings and valves free of dirt and debris. Store in a manner for easy identification of all materials.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- B. Supplier: Authorized distributor, or representative of specified manufacturer with minimum three years documented experience.

1.07 PROJECT CONDITIONS

- A. Instruments shall be provided in enclosures, or housings, suitable for the environment of the intended installed location, as shown on the Drawings, and as described herein. Manufacturer shall provide integral heater(s) and/or cooler(s) where required for proper operation under normally expected conditions. Normal ambient temperatures at the facility site range from minus 30 to plus 45 degrees Celsius (minus 25 to plus 115 degrees Fahrenheit). Instruments in outdoor locations shall be suitable for operation under these conditions, while in direct sunlight, or under windy conditions with associated "chill" factors.
- B. Maintain instruments free of dirt and dust during and after installation.

1.08 WARRANTY

- A. The manufacturer shall warrant the meter(s) to be free from defects in materials and workmanship for one (1) year after installation.

1.09 SYSTEM DESCRIPTION

- A. Electromagnetic flow meter is intended for fluid metering in potable water. No moving parts are in the flow stream. Transmitter will be remote-mounted. Unit will be ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit will provide pulse signals that can be fed to dedicated batch controllers, PLCs and other specified specialized instrumentation.

PART 2 PRODUCTS

2.01 LEVEL TRANSMITTERS (RADAR TYPE)

- A. Radar type level transmitters shall be as manufactured by Endress+Hauser, Micropilot Series FMR 20, Vega PULSWL61 or previously approved equal.

- B. The level transmitters shall convert microwave electromagnetic pulse transit time into a 4-20 ma DC signal for level indication, recording, and other use as shown on the Drawings. The level transmitter shall measure level to within accuracy of +/- 0.3% of span and repeatability shall be +/- 0.1% of span. An integral indicator for reading output signal in 0 to 100%, or other scale as indicated on the Drawings, shall be provided for each level transmitter.
- C. The level transmitter shall be suitable for operation in an environment with temperature ranging from 0 degrees C to 50 degrees C and relative humidity ranging from 0% to 95% (non-condensing). Sensors, and/or transmitter-indicators, shall be either intrinsically safe, or explosion proof, if located in areas classified as hazardous as shown on the Drawings. The level transmitter shall be suitable for operation in a closed or open tank of metallic or non-metallic construction, or in a stilling well, as indicated on the Drawings.
- D. Each level transmitter shall be of the "smart" type with communications provided for configuration by remote handheld calibrator, or by configuration software, loaded onto Owner's portable computer. The level transmitter-indicator shall be a PC-based, acoustic transit time type system, which shall utilize many discrete data samples to arrive at an average transit time. These transit time data points shall be integrated to determine the level.
- E. The transmitter shall evaluate each acoustic signal received and shall reject those which are distorted by reflections or reverberations or whose amplitude is below minimum value, or other intelligent filtering criteria. Each travel time resulting from accepted signals shall be checked to ensure that the measured time is within user-selectable limits. Level and rate-of-change-of-level limits shall be user selectable and adjustable on-site.
- F. The level transmitter-indicator shall have a alphanumeric keypad for user interface with the level transmitter. The user shall be able to enter all site-specific and operational parameters via the keypad. Parameter entry shall be aided by menu-driven, English language prompts on the unit display. The system shall also be capable of communication and set-up via a portable computer.
- G. The transmitter-indicator unit shall be installed in a NEMA Type 4X enclosure suitable for wall mounting. The keypad and display shall be mounted inside the front of the enclosure and shall be accessible by opening the front of the enclosure. The keypad shall be equipped with a password protect function to prevent unauthorized access to the level transmitter set-up functions.
- H. The transmitter-indicator shall be equipped with an EL or LCD-type level display. The system shall display any messages that indicate the type and of a signal interruption or transducer failure.
- I. The level transmitter console shall have a self-test routine that periodically checks for proper operation of the level transmitter transceiver, processor, and timing functions. The system shall alert the user to any self-test or acoustic path failure by displaying an error message on the level transmitter display. The level transmitter shall also provide a message indicating the type of failure. The level transmitter shall be designed to return to full operation following a short-term power interruption, with all stored values retained.
- J. A 4-20 mADC output of level shall be provided. The analog output shall be programmed to output 4 mADC if the level transmitter is in error mode. A 'dry' contact output (normally held open) shall indicate transmitter-indicator "trouble". Provide dry contact closure control and alarm outputs as shown on the Drawing.
- K. One RS-232C, RS-422, or RS-485 communications port shall be provided for set-up, and transmission of data.
- L. A copy of the manufacturer's configuration software, and any necessary cables and accessories, shall be provided to the Owner, for use in calibrating the transmitters. If software is not available, then two (2) handheld configurators shall be provided to the Owner.
- M. Transducer Assemblies:

1. Transducers installed on the tanks shall be of the 6 inch, flange mount, piezoelectric type, unless otherwise indicated on the Drawings. Transducer assemblies shall be constructed of corrosion resistant materials suitable for the use intended, as shown on the Drawings.
 2. Transducer cables shall be routed through raceways, and brought to a common penetration, exiting the raceway and routed to the level transmitter-indicator as shown on the Drawings.
- N. Contractor shall furnish all cable between the transducers and the electronic console. The cable shall be the type of specified by the manufacturer. Any connectors to the transducers that may be required shall be supplied by the manufacturer.

2.02 FLOAT SWITCHES (NORMAL DUTY TYPE)

- A. Pipe or chain mounted float switches shall be as manufactured by Consolidated Electric, a division of U.S. Filter (Siemens) Model LS with LSW1 weight kit or Anchor Scientific, Inc. "Rotofloat" Type SST series.
- B. Cable weight kit shall be as manufactured by Consolidated Electric, a division of U.S. Filter (Siemens): Model No. CBM or equal.
- C. Suspension mounted float switches shall be as manufactured by Conery Mfg Model B1 with C1 weight option with S.S. brackets, Consolidated Electric, a division of U.S. Filter (Siemens): Model No. CBM or Anchor Scientific, Inc. "Rotofloat" Type S.
- D. Float switches shall be direct acting with 3-1/2 inch diameter, either normally open or normally closed non-mercury switch with polypropylene shell and solid polyurethane foam filling, and flexible 18/2 conductor cable with PVC jacket suitable for heavy flexing service. Cable lengths shall be as required.
- E. Float switch contacts shall be rated 10 amps at 120 VAC.
- F. Float switches shall be suitable for pipe or support chain mounting as shown on the Drawings.
- G. Pipe mounted float switches shall be provided with a one-inch diameter stainless steel pipe, stainless steel or polypropylene float switch mounting clamps, pipe stabilization brackets, and all other necessary hardware.
- H. Support chain mounted float switches shall be provided with a stainless steel support chain, PVC coated weight, and float switch mounting clips.

2.03 FLOAT SWITCHES (CHEMICAL DUTY TYPE)

- A. Chemical and acid service float switches shall be as manufactured by Consolidated Electric Model LS or Anchor Scientific, Inc. "Rotofloat" Type P.
- B. Float switches shall be heavy duty, industrial grade polypropylene float switches suitable for insertion in 30% sulfuric acid at 130° F and/or oil/water solutions. Float switch cables shall be three conductor flexible cable with PVC jacket suitable for use in the aforementioned solutions. Cable lengths shall be as required.
- C. Float switch contacts shall be rated 5 amps at 120 VAC rating.
- D. Float switches shall be suitable for pipe or suspension mounting as shown on the Drawings.
- E. Pipe mounted float switches shall be provided with a one inch diameter, Schedule 40, plastic support pipe; polypropylene float switch mounting clamps with polypropylene screws; non-metallic pipe stabilization brackets; and all other necessary hardware.
- F. Cable cord grip connectors shall be watertight, corrosion resistant, dust-tight, and oil-resistant.
- G. The connectors shall be constructed of thermoplastic polyester material with nylon cord grip and neoprene bushing all sized to properly fit and seal around the float switch cable.
- H. Cord grip connectors shall be as manufactured by Crouse-Hinds Type NCGB.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make all instrumentation interconnections (process, electrical, etc.) as indicated and required for proper operation and intended use.
- D. See Section 26 05 53 - Electrical Identification for nameplate, circuit number marker, and wire marker, etc. requirements.

3.02 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 26 07 05 - Electrical Testing and Equipment.
- B. Perform operational testing on instrumentation and control systems to verify proper operation and field wiring connections.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Prepare, calibrate, and start systems under provisions of Section 26 08 00 - Calibration and Start-up of Systems.
- B. Calibrate and/or verify each device for the zeros, ranges, and spans indicated on the Drawings

3.04 DEMONSTRATION

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 07 10 - Demonstration and Training.
- C. After acceptance of the level equipment, the Owner's operators shall be provided with one-half day (minimum) of onsite training in the use and maintenance of the equipment. The training shall cover the calibration of the level instruments, preventative maintenance of all equipment, and troubleshooting and repair/replacement procedures.

3.05 SPARES

- A. In addition to the installed equipment, as Specified above, and as shown on the Drawings, provide one spare of each type of transmitter-indicator (or field replaceable module), and one spare primary element/sensor (complete with 30 feet of cable where the cable is integral to the sensor) or level/float switch, each packaged as indicated.
- B. For sensors of the field rebuildable, or rechargeable type, provide rebuild, and/or recharge kits adequate to service all installed sensors.
- C. Provide a calibration kit, with all necessary accessories, all packaged in a hard-side case, for each different type of sensor or transmitter. Each Kit shall be suitable for maintaining all installed instruments of that type in calibration, at the manufacturer's recommended maintenance interval, for a period of one year after acceptance.
- D. Turn over software, and all spares at the time of, and as a condition of, acceptance.

END OF SECTION

SECTION 40 90 00
PROCESS INSTRUMENTATION, CONTROLS AND MONITORING EQUIPMENT -
GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section encompasses general provisions relating to instrumentation work. Work included in this Section pertains to all instrumentation work contained in Division 26 or Division 40, unless modified therein, as though this Section was repeated in its entirety in each Section.
- B. Furnish labor, materials, equipment and accessories required to provide complete operating instrumentation at the facility as described in the specifications, listed on the schedules and shown on the Drawings.
- C. Install and/or connect furnished equipment, including equipment furnished by others, as detailed herein and as shown on the Drawings.
- D. It is the intent of these Contract Documents that the instrumentation shall be suitable in every way for the service required. Material and all work that may be reasonably implied as being required for a complete fully functioning, automated and manually controlled facility shall be furnished at no extra cost.
- E. Make field connections to process instruments and other equipment furnished under this Contract; to equipment furnished by Owner under separate contract, if any; and to reworked or relocated existing equipment as in the Contract Documents.
- F. Provide mounting, mount, and wire process instruments furnished under Contract. Furnish wire, and interconnections between process instrumentation primary elements, transmitters, local indicators, and receivers. Mount and wire surge protection equipment where indicated on the Drawings.
- G. Provide mounting, mount, and make field connections to "packaged" instruments furnished under this Contract. Electrically or pneumatically connect "package" control systems to other related panels or instrumentation defined by the Contract Documents.
- H. Process Instrumentation equipment and materials furnished under this Contract, shall be installed under Division 40. This installation Work shall include mounting and making of process and signal connections to the equipment. This Work, with the exception of factory-mounting of certain instruments, shall be performed under the supervision of a qualified representative of the vendor of the system or equipment. This installation Work and the completed installation shall be in compliance with instructions of the above-mentioned vendor's representative and in accordance with the Drawings and documentation prepared by the vendor of the system or equipment and approved by Engineer.

1.02 RESPONSIBILITIES

- A. Contractor shall assume responsibility to take field measurements of related and connecting work, and to determine the entire scope of the work required for a finished and completed project, in accordance with the Contract Documents and as approved by Engineer.
- B. Drawings upon which this Contract is based show the arrangement, general design and extent of the systems and components. Systems are suitably outlined on the Drawings with regard to size, locations, general arrangements and installation details. Connections are shown in diagram form, except where in certain cases the drawings may include details giving the exact locations and arrangements. Drawings shall not be scaled to determine location. Work shall be installed in such a manner to avoid interferences.
- C. Where any parts of the systems or piece of equipment are located by dimensions on the Drawings, said dimensions shall be checked and verified in the field. Should discrepancies or interferences occur which will necessitate major revisions in the work, Engineer shall be notified

immediately, and his authority secured in writing for such revisions before proceeding with the Work.

- D. Drawings are intended to convey the desired method of control and operation of the instrumentation and control system. Contractor shall retain the services of the Control System Supplier to be responsible for the system analysis, design and functional adequacy of equipment necessary to achieve required systems performance and to satisfy the intent of these Contract Documents.
- E. Instrumentation and controls shall be installed under the supervision of the Control System Supplier. Insofar as possible, instrumentation and control equipment shall be furnished from a single supplier. Contractor shall retain the services of the Control System Supplier to supply the complete control and instrumentation system and prepare wiring diagrams, installation drawings and changes for existing equipment.
- F. Modifications or additions to the electrical conduit and wiring installation for the instrumentation and control system required by the instrumentation and control system and not shown on the Contract Drawings shall be furnished and installed by Contractor, as approved by the equipment manufacturers. Other devices or wiring including energy sources and/or converters necessary to obtain proper operation of the instrumentation and control system, shall be provided and installed by Contractor. Special interface equipment required shall be provided and installed by Contractor at no additional cost to Owner.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 77 00 - Closeout Procedures
- C. Section 26 05 00 - Common Work Results for Electrical
- D. Section 26 05 10 - Basic Electrical Materials and Methods
- E. Section 40 91 00 - Instrumentation and Controls

1.04 REFERENCE STANDARDS

- A. Equipment, materials, and systems provided shall be designed, manufactured, finished, painted, tested, inspected, packaged, shipped, stored, installed, connected, and tested in accordance with the General Industry Standards of OSHA, local, county, state, and federal laws, and in accordance with the published codes, standards, and the following Standard Specifications:
 - 1. ANSI - American National Standards Institute
 - 2. ASTM - American Society for Testing and Materials
 - 3. AWWA - American Water Works Association
 - 4. IEEE - Institute of Electrical and Electronics Engineers
 - 5. ISA - Instrument Society of America
 - 6. NEC - National Electric Code
 - 7. NEMA - National Electrical Manufacturers Association
 - 8. NFPA - National Fire Protection Association
 - 9. OSHA - Occupational Safety and Health Administration (U.S. Depart. of Labor)
 - 10. UL - Underwriter's Laboratories

1.05 REGULATORY REQUIREMENTS

- A. Equipment, materials, and systems shall be UL labeled or listed except for classes of materials and equipment not available with such listing.

1.06 SUBMITTALS

A. Shop Drawings:

1. Certified drawings and diagrams for all instrumentation and control work shall be furnished by Contractor and delivered to Engineer in accordance with Section 01 33 00, Submittal Procedures. Information to be submitted for approval shall include:
 - a. Schematic Wiring Diagrams
2. Contractor shall submit wiring diagrams of each piece of equipment, termination cabinet, starter, switch, relay, indicator, controller, recorder, annunciator, telemetering equipment, etc.
3. Drawings shall be 24" x 36" with border, title block, symbols, etc., as used on the Contract Drawings and approved by Engineer. Ladder diagrams and wiring diagrams shall conform to JIC format and include line numbers, item numbers, source of power, terminal numbers, wire numbers, etc. Wire numbers and item numbers shall be assigned using the line numbers on the ladder diagrams.
4. Submit operating and maintenance instructions of all instrumentation and control components and equipment in accordance with Section 01 33 00.
5. Where applicable, and if Contractor desires, he may purchase mylars, vellums or electronic files (when approved by Engineer) of the process control drawings from Engineer, modify these drawings as required, and utilize them as shop drawings.
6. Bond copies will be acceptable for the approval issue only.
7. Manufacturer's specifications complete with descriptive information indicating design data underscored to assist in verification that equipment proposed is equal to or exceeds the technical requirements and intent of these specifications. Design data shall cover exact equipment furnished.
8. Dimensional outline drawings of all control and instrument enclosures including designated conduit or wireway entrances, internal equipment layouts and structural details.
9. Internal wiring diagrams of control enclosures identifying terminals and showing external and interconnecting terminals and field mounted devices.
10. Details necessary for fabrication of equipment specific to these control systems.
11. Working and/or construction drawings, showing conduit layout, locations, details, size, wire size and type and cables therein.
12. Technical information for all devices furnished.
13. Cable schedule detailing each cable, routing and all connections, as described in a format approved by Engineer.
14. A riser diagram shall be provided showing all cables, wires and conduits.
15. A complete list of all recommended spare parts and test equipment required for the upkeep of all instruments and controls devices installed under this Contract.
16. Complete parts lists of all materials and components incorporated in the system.
17. Individual manufacturer's instruction manuals for all devices.
18. Contractor shall submit as-built drawings, instruction manual material and assistance as required by Sections 01 77 00.

B. Certified Reports:

1. Contractor shall submit a certified report for control panel and associated field instruments certifying that the equipment:
 - a. Has been properly installed under Control System Supplier's supervision.
 - b. Is in accurate calibration.
 - c. Was placed in operation in under Control System Supplier's presence.
 - d. Has been checked, inspected, calibrated, and adjusted as necessary.
 - e. Has been operated under maximum power variation conditions and has operated satisfactorily.
 - f. Is fully covered under the terms of the guarantee.
- C. Operations and Maintenance Data:
 1. Submit operating and maintenance instructions of all instrumentation and control components and equipment in accordance with Section 01 33 00 and Section 01 77 00.

1.07 QUALITY ASSURANCE

- A. Instruments and controls shall be installed under the supervision of Control System Supplier.
 1. To ensure a coordinated instrumentation and control system, Contractor shall require the Control System Supplier to certify coordination of the overall control and instrumentation system so that all devices provided under this Contract are compatible and provide a complete and operable system.
 2. Control System Supplier shall inspect each component piece of equipment supplied for each system to assure that it is new, in good working order and complies with the intent of Contract Documents.
 3. Components not fulfilling these criteria shall be rejected.

1.08 INSTRUMENT IDENTIFICATION

- A. Major instrumentation and equipment items or system specified shall be identified by system and tag numbers. This same number appears in the tag number designations on the drawings and on the schedule.
- B. Instrumentation and equipment shall be identified by nameplates or tags.
- C. Nameplates for panels and panel mounted equipment shall be as specified in the respective Section.
- D. Field equipment shall be tagged with assigned instrumentation tag number and function.
 1. Tags shall be white lamacoid with engraved black characters of 3/16 inch minimum height.
 2. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard hose clamps and meeting the same description. In cases where this would be impractical, use 20 gage stainless steel screws installed in an unobtrusive manner.
- E. In addition to tags, field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed.
 1. Nameplate shall be attached by one of the above methods.

1.09 SIGNAL ISOLATORS, CONVERTERS, AND CONDITIONERS

- A. Ensure that input-output signals of all instruments and control devices are compatible.
- B. Unless otherwise specified, signals between field and panels shall be 4 to 20 mA DC unless specifically approved otherwise.

- C. Granting such approval does not relieve the compatibility requirement above.
- D. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices inside or behind control panels, or in the field at point of application.

1.10 PROCESS CONNECTIONS

- A. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance.
- B. Slope lines according to service to promote a self-draining or venting back to the process.
- C. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shutdown of the process.
- D. Include drip legs and blow-down valves for terminations of sensing lines at the instruments when mounted in such a way that condensation can accumulate.
- E. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished by Contractor.

1.11 MANUFACTURER'S SERVICE

- A. General:
 - 1. Contractor shall furnish the services of a factory representative of the instrumentation equipment manufacturer to provide field supervision during installation, to direct the installation of the equipment, and to conduct initial equipment checkout and system start-up.
 - 2. Contractor shall furnish the services of a factory trained and qualified serviceman of the manufacturers of the instrumentation equipment and accessories supplied under this Contract to perform the following:
- B. Supervision:
 - 1. Supervisory service of a trained serviceman, specifically trained on the type of equipment herein specified, shall be provided during construction to assist in, location of sleeves, methods of installing conduit and special cable, mounting piping and wiring for each type of device, and the methods of protecting all of the equipment prior to placing it in service.
- C. Power Check-Out:
 - 1. Checking the installation of all components before power is applied.
 - 2. No form of energy shall be applied to any part of the instrumentation system prior to receipt by Engineer of a certified statement of approval of the installation from Contractor, containing his Control System Supplier's authorization for turning on energy to the system.
- D. Check-Out:
 - 1. Placing the equipment into operation and making necessary adjustments including tests and loop checks.
 - 2. Contractor shall provide the Control System Supplier's services to maintain all control system equipment in good operating condition and furnish-on-call maintenance as required to minimize equipment down time, until the project has attained Substantial Completion.
 - a. Control System Supplier shall provide scheduled preventative maintenance based on Engineer approved listing specifying the time required for preventative maintenance on the various types of equipment and shall provide remedial maintenance services as required.

- b. Additional service time shall be provided during the one-year warranty period for at least three 8-hour day service visits to the site to check and readjust the equipment supplied under this Section.

1.12 SHIPPING PRECAUTIONS

- A. After completion of shop assembly and tests, all control cabinets, panels and consoles, etc., shall be enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from dust and moisture.
- B. Dehumidifiers or desiccant materials shall be placed inside the polyethylene coverings prior to sealing. Equipment shall then be skid mounted and braced for final transport.
- C. Lifting rings shall be provided for moving without removing protective coverings on all sections weighing more than 150 lbs. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling.
- D. Equipment provided under this Contract shall not be delivered to the job site until scheduled for installation.
- E. Special instructions for proper field handling and installation required by the manufacturer for proper protection shall be securely attached to each piece of equipment prior to shipment.
- F. Each package shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on outside of package.
- G. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, shall be provided on each piece of equipment supplied under the Contract.

1.13 DELIVERY, STORAGE AND HANDLING

- A. Special instructions for proper field handling and installation required by the manufacturer for proper protection shall be securely attached to each piece of equipment prior to shipment.
- B. Each package shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on outside of package.
- C. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, shall be provided on each piece of equipment supplied under the Contract.
- D. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters and shall be adequately protected against mechanical injury or damages by water.

1.14 GUARANTEES AND WARRANTIES

- A. Contractor shall guarantee work in accordance with the requirements of the Conditions of the Contract. With respect to instruments and equipment, guarantee shall cover:
 - 1. Faulty or inadequate design
 - 2. Improper assembly or erection
 - 3. Defective workmanship or materials
 - 4. Leakage, breakage, or other failure not caused by Owner misuse.
- B. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty with Owner named as beneficiary.

1.15 TOOLS

- A. One complete sets of any specialty instrument required to adjust and calibrate the instrumentation equipment shall be furnished with the equipment.

- B. They shall include hand tools for maintenance and calibration such as: unique screwdrivers and wrenches plus other tools as required.
- C. They shall be supplied in a durable case.
- D. Calibration tools for instrumentation equipment such as magmeters, flowmeters, and pneumatic instruments shall also be provided.
- E. A universal, portable input-output calibrator shall be provided.
- F. The unit shall be suitable for use as a current or voltage source, current or voltage measuring device and as a power supply for two wire transmitters.
- G. Output section shall contain 6 current and 5 voltage ranges.
- H. Internal power supply shall contain 3 ranges.
- I. A self-contained portable potentiometer shall also be provided.
- J. Tester shall be Fluke model 789 or Engineer approved equal.

1.16 SPARE PARTS

- A. Spares consumed during installation and testing shall be replaced by Contractor prior to final acceptance of the system.
- B. Control System Supplier shall supply a complete list of all suggested spare parts and supplies he considers required for the continuous operation of the system.
- C. List shall include catalog and serial numbers of the hardware devices, spare parts part numbers, commercial part numbers and price in effect when the list is prepared.
- D. Spare parts shall be 100% of the manufacturer's recommended spare parts for each device.

PART 2 PRODUCTS

2.01 GENERAL

- A. Electronic instrumentation shall be of the solid-state type, of manufacturer's latest design; preferably designed and packaged for miniature, high density mounting configuration.
 - 1. Where available, the instruments will be supplied with self-supporting, draw-out feature when in extended position.
 - 2. Transmitted analog signals shall be 4-20 mAdc; however, signals between instruments within the same panel/cabinet may be 1-5V.
 - 3. Zero base transmission signals will not be allowed, only "live zero" signals. An exception would include outputs of sensing devices specified hereafter, however, converted to compatible high-level signals for remote transmission.
- B. Field mounted equipment shall be in NEMA 4X enclosures and, if required, shall include suitable strip heaters to prevent accumulation of moisture.
- C. Equipment installed in hazardous areas, shall meet Class I, Group D, Division I to comply with the National Electrical Code.
- D. Indicators and recorder readouts will be linear in process units.
- E. Transmitters shall be provided with either integral indicators or separately mounted indicators reading in process units. Special features listed in the individual instrument specifications are required and all information listed therein shall be considered as minimum requirements.
- F. Equipment furnished shall be approved for specific application by Underwriter's Laboratories, Inc., or Factory Mutual if applicable.

2.02 ELECTRICAL

- A. Refer to Division 26.
- B. Equipment shall be designed to operate on a 60 Hertz alternating current power source at 105 to 135 volts, except as noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- C. Switches shall have single-pole double-throw contacts rated at 600 VA.
- D. Contacts for low voltage signals shall be gold flashed.

2.03 POWER FAILURE

- A. Equipment shall be designed and constructed so that in the event of a power interruption the equipment shall resume normal operation without manual resetting when power is restored.

2.04 CONTROL SYSTEM SUPPLIERS

- A. Available Control System Suppliers: Subject to compliance with requirements, provide a Control System Supplier of the following:
 - 1. MAK Controls
- B. Equipment specified and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to job site, and started up by a qualified and approved Control System Supplier listed under this heading. Intent is for unit responsibility.
- C. Control System Supplier shall not assign any of his rights or delegate any of his obligations.
- D. Direct purchase of any items by Contractor is not in compliance with this Specification and will not be permitted.
- E. Control System Supplier shall assign a qualified representative to act as Project Engineer for the work efforts specified. Control System Supplier shall submit a resume outlining the qualifications of this individual to Engineer for approval within 3 days of notice to proceed. Project Engineer shall, at a minimum, have the following qualifications:
 - 1. Successfully completed vendor factory training for the digital equipment supplied.
 - 2. Successfully completed projects of similar size and complexity.
- F. Project Engineer shall be interviewed by Engineer after the contract has been awarded. Individuals selected as Project Engineer must be approved by Engineer. Individuals not approved by Engineer shall not function as Project Engineer.
- G. Project Engineer shall be the focal point for all design, fabrication, contract communications, and construction and shall be responsible for start-up and acceptance.
 - 1. Project Engineer shall be at the factory test, at the job site during the entire construction process start-up, and at the job site during the entire acceptance procedure.
 - 2. Only qualified and approved Control System Suppliers will be accepted as meeting this Specification.
 - 3. Control System Supplier shall also assign a full-time service technician during the construction process effort to assist in verifying and making minor corrections to wiring which may be necessary as determined by Engineer.
 - 4. Start-up/acceptance procedure shall not begin until all installation has been completed and any punch list items are minor in nature.
- H. Installation and Start-up. Control System 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 six (6) hours travel time by ground from the jobsite.

2.05 TRAINING

A. General:

1. Contractor shall provide two 8-hour days of training of Owner's personnel in aspects of operation and maintenance such as direction on calibration of field instruments, fuse locations, instruction manuals, etc.
2. At-the-plant training and instructions shall be given by the Project Engineer assigned to the project by the Control System Supplier or other personnel as approved by Engineer.

B. Digital Equipment:

1. Control System Supplier shall provide comprehensive instruction for the programmable controllers and software packages supplied. This instruction shall be performed by the manufacturer of the products at their factory training facility.
2. Owner shall determine actual division of attendance. Written course materials shall be included along with hands-on exercises with instructional equipment. Factory training shall be conducted on a schedule acceptable to Owner and shall commence prior to system factory testing.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of instruments and equipment.

3.02 CERTIFIED REPORTS

- A. Contractor shall submit a certified report for control panel and associated field instruments certifying that the equipment:
1. Has been properly installed under Control System Supplier's supervision.
 2. Is in accurate calibration.
 3. Was placed in operation in under Control System Supplier's presence.
 4. Has been checked, inspected, calibrated, and adjusted as necessary.
 5. Has been operated under maximum power variation conditions and has operated satisfactorily.
 6. Is fully covered under the terms of the guarantee.

3.03 DEMONSTRATION AND FINAL OPERATING TEST PLANS AND RESULTS

- A. Submit for approval, a written plan for demonstrating that each system of equipment provided meets the specified operational requirements.
1. The plan shall include procedures to be used in final operational testing of entire system including description for each system of test methods and materials, testing instruments and recorders, a list of the equipment involved with the functional parameters to be recorded on each item, and shop drawings of required temporary bypasses and like facilities.

3.04 PREPARATION

- A. Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a broom-clean condition during installation operations.

3.05 INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with the Control System Supplier's instructions.
 - 1. Locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by Engineer during construction.
 - 2. Field verify information relevant to the placing of process control equipment and in case of any interference, proceed as determined by Engineer.
 - 3. Furnish labor and materials necessary to complete the work in an approved manner.
- B. Instrumentation loop diagrams on the Drawings indicate the intent of the interconnection for the instruments specified.
 - 1. Work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, Contractor shall bear full responsibility for such violations and assume all costs arising there from.
 - 2. Field instruments requiring power supplies shall be provided with local electrical shut-offs.
- C. Brackets and hangers required for mounting of equipment shall be provided and shall be installed in a workmanlike manner so as to not interfere with other equipment.
 - 1. Contractor shall investigate each space in the building through which equipment must pass to reach its final location.
 - 2. If necessary, the manufacturer shall be required to ship this material in sections sized to permit passing through such restrictive areas in the building.
- D. The shield on each process instrumentation cable shall be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground be employed for each shield.
 - 1. Cable shields will be continuously maintained by termination to "shield" terminals which are not grounded except at the Main Control Panel. The sole exception is if the manufacturer requires ground of the shield at the field device.
- E. Each pair of wires shall be tagged within four inches of each termination with the assigned cable, pair and terminal numbers.
 - 1. Low energy signal (4-20 mAdc) shall be run in instrumentation cables in conduits separated from AC power, control and annunciator wiring.
 - 2. Lifting eyes shall be removed from cabinets/assemblies.
 - 3. Holes in cabinet or boxes shall be plugged.
 - 4. The plug will be of the same color as the cabinet or box and shall be gasketed.

3.06 CALIBRATION AND SYSTEM VALIDATION

- A. Calibration:
 - 1. Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications instructions for calibration.
 - 2. Each instrument shall be calibrated at 10%, 50%, and 90% of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Such test instruments shall have accuracies traceable to the National Bureau of Standards, as applicable.

3. Provide a list and basic specifications for instruments used.
4. Provide a written report to Engineer on each instrument certifying that it has been calibrated to its published specified accuracy.
 - a. Report shall include applicable data as listed below plus any defects noted, correction action required, and correction made.
 - b. Data shall be recorded on prepared forms and shall include not less than the following items.
 - 1) Facility identification (name, location).
 - 2) Loop identification (name or function).
 - 3) Equipment tag and serial numbers.
 - 4) Scale ranges and units.
 - 5) Test mode or type of test.
 - 6) Input values or settings.
 - 7) Expected outputs and tolerances.
 - 8) Date of actual calibration.
 - 9) Actual readings.
 - 10) Explanations or special notes as applicable.
 - 11) Tester's certification with name and signature.

B. System Validation:

1. Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance.
 - a. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.
2. Validate each system by simulating inputs at the first element in loop (i.e., sensor) of 10%, 50%, and 90% of span, or on/off and verifying loop output devices (i.e., recorder, indicator, alarm, etc., except controllers).
 - a. During system validation, make provisional settings on levels, and alarms.
 - b. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.
 - c. Verify that alarms and logic sequences operate in accordance with the specifications.
3. Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation.
4. Immediately correct defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.
5. Provide a report certifying completion of validation of each instrument system.
 - a. Report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices.
 - b. Data sheets shall be similar to those used for calibration.

3.07 FINAL OPERATIONAL TESTING AND ACCEPTANCE

- A. Upon completion of instrument calibration and system validation, test system under process conditions.
 - 1. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems.
 - 2. Testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and mechanical equipment.

3.08 DEMONSTRATION AND FINAL OPERATING TEST PLANS AND RESULTS

- A. Submit for approval, a written plan for demonstrating that each system of equipment provided meets the specified operational requirements.
 - 1. The plan shall include procedures to be used in final operational testing of entire system including description for each system of test methods and materials, testing instruments and recorders, a list of the equipment involved with the functional parameters to be recorded on each item, and shop drawings of required temporary bypasses and like facilities.
- B. Upon completion of instrument calibration and system validation, test system under process conditions.
 - 1. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems.
 - 2. Testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and mechanical equipment.
- C. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat and testing.
- D. Upon completion of final operational testing, submit certified report, with substantiating data sheets, indicating that total instrumentation and control system meets the functional requirements specified herein.
- E. Testing shall be observed by Engineer.
 - 1. Notify Engineer in writing a minimum of 48 hours prior to the proposed date for commencing the testing.
 - 2. Upon completion of this test Contractor shall begin or have begun system start-up.
 - 3. Owner reserves the right to set the schedule.

3.09 MANUFACTURER'S SERVICES

- A. General:
 - 1. Contractor shall furnish the services of a factory representative of the instrumentation equipment manufacturer to provide field supervision during installation, to direct the installation of the equipment, and to conduct initial equipment checkout and system start-up.
 - 2. Contractor shall furnish the services of a factory trained and qualified serviceman of the manufacturers of the instrumentation equipment and accessories supplied under this Contract to perform the following:
 - a. Start-Up Assistance:
 - 1) Provide the services of a factory trained and field experienced instrumentation engineer for a minimum of 1 day at the project site to assist Engineer in field

checkout and start-up of software. This period shall be scheduled by Engineer.

- 2) Provide the services of a factory trained and field experienced instrumentation engineer for a minimum of two (2) working days to assist Owner's personnel during startup of the system. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

b. Coordination:

- 1) Work shall be coordination with other trades involved in the construction project.
- 2) Work shall be carefully laid out in advance so that architectural, structural, mechanical, electrical, and instrumentation features of construction will be coordinated.

c. Supervision:

- 1) Supervisory service of a trained serviceman, specifically trained on the type of equipment herein specified, shall be provided during construction to assist in, location of sleeves, methods of installing conduit and special cable, mounting piping and wiring for each type of device, and the methods of protecting all of the equipment prior to placing it in service.

d. Power Check-Out:

- 1) Checking the installation of all components before power is applied.
- 2) No form of energy shall be applied to any part of the instrumentation system prior to receipt by Engineer of a certified statement of approval of the installation from Contractor, containing his Control System Supplier's authorization for turning on energy to the system.

e. Check-Out:

- 1) Placing the equipment into operation and making necessary adjustments including tests and loop checks.
- 2) Contractor shall provide the Control System Supplier's services to maintain all control system equipment in good operating condition and furnish-on-call maintenance as required to minimize equipment down time, until the project has attained Substantial Completion.
 - (a) Control System Supplier shall provide scheduled preventative maintenance based on Engineer approved listing specifying the time required for preventative maintenance on the various types of equipment and shall provide remedial maintenance services as required.
 - (b) Additional service time shall be provided during the one-year warranty period for at least three 8-hour day service visits to the site to check and readjust the equipment supplied under this Section.

3. Training:

- a. Contractor shall provide two 8-hour days of training of Owner's personnel in aspects of operation and maintenance such as direction on calibration of field instruments, fuse locations, instruction manuals, etc.
- b. At-the-plant training and instructions shall be given by the Project Engineer assigned to the project by the Control System Supplier or other personnel as approved by Engineer.
- c. Digital Equipment:

- 1) Control System Supplier shall provide comprehensive instruction for the programmable controllers and software packages supplied. This instruction shall be performed by the manufacturer of the products at their factory training facility.
- 2) Contractor shall submit to Engineer, an outline of the proposed training courses to meet the requirements set forth below.
 - (a) Hardware training (3 individuals)
 - (1) 1 day, Maintenance and Troubleshooting
 - (b) Software training (3 individuals)
 - (c) 1 day, Software Concepts
- 3) Contractor shall also provide to Engineer a list of additional courses available from the manufacturer.
- 4) Upon review, Engineer may request that a substitution be made of a course content that better fits the needs of Owner. Such substitution shall only be requested for courses of equal length cost and availability.
- 5) Owner shall determine actual division of attendance. Written course materials shall be included along with hands-on exercises with instructional equipment. Factory training shall be conducted on a schedule acceptable to Owner and shall commence prior to system factory testing.
- 6) For training conducted at other than Owner's facilities, Contractor shall bear all transportation (air fare, car rental, etc.) and subsistence (hotel, meals, etc.) costs for training.
 - (a) Daily subsistence allowance shall be \$150/day/person.
 - (b) Contractor shall arrange for all training for Owner with a minimum of 6 week notification of training schedule prior to actual course being provided.
 - (c) Scheduling of courses and their contents shall be approved by Engineer and provided at a time and location agreeable to Owner.
 - (d) Course shall be conducted at locations normally established for such courses by manufacturers of software and computer products.

3.10 FINAL OPERATIONAL TESTING AND ACCEPTANCE

- A. Upon completion of instrument calibration and system validation, test system under process conditions.
 1. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems.
 2. Testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and mechanical equipment.
- B. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat and testing.
- C. Upon completion of final operational testing, submit certified report, with substantiating data sheets, indicating that total instrumentation and control system meets the functional requirements specified herein.
- D. Testing shall be observed by Engineer.
 1. Notify Engineer in writing a minimum of 48 hours prior to the proposed date for commencing the testing.

2. Upon completion of this test Contractor shall begin or have begun system start-up.
3. Owner reserves the right to set the schedule.

3.11 START-UP ASSISTANCE

- A. Provide the services of a factory trained and field experienced instrumentation engineer for a minimum of 1 day at the project site to assist Engineer in field checkout and start-up of software. This period shall be scheduled by Engineer.
- B. Provide the services of a factory trained and field experienced instrumentation engineer for a minimum of two (2) working days to assist Owner's personnel during startup of the system. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

3.12 COORDINATION

- A. Work shall be coordination with other trades involved in the construction project.
- B. Work shall be carefully laid out in advance so that architectural, structural, mechanical, electrical, and instrumentation features of construction will be coordinated.

3.13 DIGITAL EQUIPMENT

- A. Digital equipment supplier shall provide an authorized, service representative for a minimum of three times at jobsite, including once during installation and start-up and once during acceptance to inspect and check out the control system.
- B. Service representative shall revisit jobsite 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.

END OF SECTION

SECTION 40 91 00 INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the design, fabrication and installation of the various instrumentation and control elements and systems required for this facility, whether supplied under this Section or with equipment furnished under other Sections of these Specifications. Control systems and components are shown on the drawings using programmable controllers. However, manual controls and emergency float control schemes for the pump systems shall be hardwired, with relays, where shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 26 05 00 - Common Work Results for Electrical
- B. Section 26 05 10 - Basic Electrical Materials and Methods

1.03 REFERENCE STANDARDS

- A. Unless otherwise specified, the Work of this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. AWWA - American Water Works Association
 - 2. FM - Factory Mutual Insurance Underwriters
 - 3. ISA - Instrument Society of America
 - 4. JIC - Joint Industrial Council
 - 5. NEMA - National Electrical Manufacturers Association

1.04 REGULATORY REQUIREMENTS

- A. Equipment, materials, and systems shall be UL labeled or listed except for classes of materials and equipment not available with such listing.

1.05 SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Submit operating and maintenance instructions of all instrumentation and control components and equipment in accordance with Section 26 05 00 - Common Work Results for Electrical and Section 40 90 00 - Process Instrumentation, Controls and Monitoring Equipment - General Requirements.

1.06 QUALITY ASSURANCE

- A. Instruments and controls shall be installed under the supervision of Control System Supplier.
 - 1. To ensure a coordinated instrumentation and control system, Contractor shall require the Control System Supplier to certify coordination of the overall control and instrumentation system so that all devices provided under this Contract are compatible and provide a complete and operable system.
 - 2. Control System Supplier shall inspect each component piece of equipment supplied for each system to assure that it is new, in good working order and complies with the intent of Contract Documents.
 - 3. Components not fulfilling these criteria shall be rejected.

PART 2 PRODUCTS

2.01 GENERAL

- A. Electronic instrumentation shall be of the solid-state type, of manufacturer's latest design; preferably designed and packaged for miniature, high density mounting configuration.
 - 1. Where available, the instruments will be supplied with self-supporting, draw-out feature when in extended position.
 - 2. Transmitted analog signals shall be 4-20 mAdc; however, signals between instruments within the same panel/cabinet may be 1-5V.
 - 3. Zero base transmission signals will not be allowed, only "live zero" signals. An exception would include outputs of sensing devices specified hereafter, however, converted to compatible high-level signals for remote transmission.
- B. Field mounted equipment shall be in NEMA 4X enclosures and, if required, shall include suitable strip heaters to prevent accumulation of moisture.
- C. Equipment installed in hazardous areas, shall meet Class I, Group D, Division I to comply with the National Electrical Code.
- D. Indicators and recorder readouts will be linear in process units.
- E. Transmitters shall be provided with either integral indicators or separately mounted indicators reading in process units. Special features listed in the individual instrument specifications are required and all information listed therein shall be considered as minimum requirements.
- F. Equipment furnished shall be approved for specific application by Underwriter's Laboratories, Inc., or Factory Mutual if applicable.

2.02 ELECTRICAL

- A. Refer to Division 26.
- B. Equipment shall be designed to operate on a 60 Hertz alternating current power source at 105 to 135 volts, except as noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- C. Switches shall have single-pole double-throw contacts rated at 600 VA.
- D. Contacts for low voltage signals shall be gold flashed.

2.03 POWER FAILURE

- A. Equipment shall be designed and constructed so that in the event of a power interruption the equipment shall resume normal operation without manual resetting when power is restored.

2.04 CONTROL SYSTEM SUPPLIERS

- A. Available Control System Suppliers: Subject to compliance with requirements, provide a Control System Supplier of the following:
 - 1. MAK Controls
- B. Equipment specified and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to job site, and started up by a qualified and approved Control System Supplier listed under this heading. Intent is for unit responsibility.
- C. Control System Supplier shall not assign any of his rights or delegate any of his obligations.
- D. Direct purchase of any items by Contractor is not in compliance with this Specification and will not be permitted.

- E. Control System Supplier shall assign a qualified representative to act as Project Engineer for the work efforts specified. Control System Supplier shall submit a resume outlining the qualifications of this individual to Engineer for approval within 3 days of notice to proceed. Project Engineer shall, at a minimum, have the following qualifications:
 - 1. Successfully completed vendor factory training for the digital equipment supplied.
 - 2. Successfully completed projects of similar size and complexity.
- F. Project Engineer shall be interviewed by Engineer after the contract has been awarded. Individuals selected as Project Engineer must be approved by Engineer. Individuals not approved by Engineer shall not function as Project Engineer.
- G. Project Engineer shall be the focal point for all design, fabrication, contract communications, and construction and shall be responsible for start-up and acceptance.
 - 1. Project Engineer shall be at the factory test, at the job site during the entire construction process start-up, and at the job site during the entire acceptance procedure.
 - 2. Only qualified and approved Control System Suppliers will be accepted as meeting this Specification.
 - 3. Control System Supplier shall also assign a full-time service technician during the construction process effort to assist in verifying and making minor corrections to wiring which may be necessary as determined by Engineer.
 - 4. Start-up/acceptance procedure shall not begin until all installation has been completed and any punch list items are minor in nature.
- H. Installation and Start-up. Control System 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 six (6) hours travel time by ground from the jobsite.

PART 2 PRODUCTS

3.01 EQUIPMENT

- A. This Specification describes the "minimum requirements" of the instrumentation and controls and includes the special features required for each.
- B. This Specification describes the "minimum requirements" of the Instrumentation and Control hardware required for this Project. Any deviations from this Specification shall be considered not acceptable. See P&ID in Contract Drawings.
- C. Float Switches:
 - 1. Function: Provide discrete level measurement.
 - 2. Operation: Changes in level causing tilt in float activating switch.
 - 3. Float Material: Polypropylene, or material compatible with the fluid that is contact with the float.
 - 4. Cable: Length as required; Type SO Nitril PVC jacketed with 3 No. 14 AWG stranded conductors.
 - 5. Switch Rating: Mechanical switch (no mercury), 10 amps at 115 VAC.
- D. Proximity Switches:
 - 1. Function: Provide indication of presence or movement of mechanical components
 - 2. Operation: Changes in level causing tilt in float activating switch.
 - 3. Enclosure: Stainless steel, side sensing, intrinsically safe

4. Cable: Length as required; Type SO Nitril PVC jacketed with 3 No. 14 AWG stranded conductors.
 5. Switch Rating: SPDT switch, 10 amps at 115 VAC, 3 amps at 24 VDC.
 6. Manufacturer: Subsea Model 11 GO Switch by Emerson Process Management
- E. Intrinsically Safe Relay:
1. Function: Interface control in explosive atmospheres
 2. Type: Solid state electronic
 3. Input Signal Value: Less than 1 ma @ 9.6 VDC
 4. Output Signal Value: Contact closure - 10 amp resistive rated 2 N.O. + 2 N.C. independent and isolated
 5. Power Supply: 120 V - 1 PH - 60 HZ
 6. Power Consumption: 6 watts or 9 V.A.
 7. Power Terminals: Plug-in quick connect tabs
 8. Approval: FM (Factory Mutual)
 9. Sensitivity Adjust: 10,000 ohm to 1 megohm
 10. Manufacturer: Turck IM1-22EX-R, or equal
- F. Electronic Dual Current Switch:
1. Function: Monitor input signal and trip at set point
 2. Type: Direct current switch suitable for panel mounting
 3. Input: 4 to 20 MA
 4. Output: DPDT relay contacts rated 5 A at 117 VAC noninductive
 5. Power: 117 VAC 50/60 HZ at 10%
 6. Manufacturer: Adtech or equal
- G. Pilot Indicating Light:
1. Function: Visual indication of control function
 2. Type: Heavy-duty; oil-tight or weatherproof as required; transformer type; push-to-test LED
 3. Input: 120 volts, 60 HZ
 4. Color Cap: Plastic
 5. Color Designation:
 - a. Red - "Stop" or "Alarm"
 - b. Green - "Start" or "Running"
 - c. Blue - "Overload"
 - d. White - "Power On" or "Opened"
 - e. Amber - "Closed"
 - f. Clear - "Defined Status" "Ground"
 6. Mounting: Mounting hole 1 13/64" D; Pilot hole 1/4" D; Space between holes 9/16" minimum

H. Pushbutton:

1. Function: Manual operator control
2. Type: Oil-tight or weatherproof, momentary or maintained contact as required; emergency stop shall be maintained, push to open, pull to close
3. Contacts: 1 N.O. and 1 N.C. (minimum) Provide contact arrangements as required to perform desired control
4. Rating: 10 amp @ 120 VAC continuous
5. Mounting: Mounting hole 1 13/64" D
6. Operator: Extended head
 - a. Start, open, close or run function - black operator
 - b. Stop function - red operator
 - c. Silence - black operator

I. Selector Switch:

1. Function: Manual control mode selection
2. Type: Heavy-duty, Oil-tight or weatherproof, as required
3. Application: See Contract Drawings
4. Positions: Two-three-four (as required)
5. Contacts: Form a or Form b (as required) (Form c not acceptable)
6. Operator: Knob level type
7. Contact Rating: 120 VAC - 10 amp continuous (60 amp make - 6 amp break)
8. Mounting: Mounting hole 1 13/16" D
9. Options:
 - a. Spring return as required
 - b. Cylinder key lock as required

J. Gage Pressure Transducer/Transmitter:

1. Function: Provide analog pressure measurement
2. Type: Pressure transducer with 4-20 mA output proportional to system pressure
3. Housing: NEMA 4
4. Fill Fluid: Silicone Oil
5. Wetted Parts: 316L Stainless Steel
6. Output: 4-20 mA analog signal
7. Manufacturer: Siemens Sitrans P

K. Redundant Power Supply:

1. Function: Provide 24 volt power
2. Type: Switching redundant power supply with controller
3. Input: 115 VAC
4. Output: 24 VDC
5. Housing: NEMA 12

6. Ripple: No more than 50 mV peak to peak
 7. Manufacturer: Puls QS10.241 supply, with YRM2.DIODE or SOLA SDN-24-100P supply with SDN 2.5-20RED
- L. Temperature Transducer/Transmitter:
1. Function: Provide analog temperature measurement
 2. Type: Transmitter/transducer with 4-20 mA output proportional to ambient temperature
 3. Housing: NEMA 7
 4. Range: 0 - 100 degrees Fahrenheit
 5. Wetted Parts: 316L Stainless Steel
 6. Output: 4-20 mA analog signal
 7. Certification: Factory Mutual (Class I, Division I)
 8. Manufacturer: Dwyer Instruments model TTE-106-W-LCD with A-287 pipe mounting bracket, or Engineer approved equal.
- M. Pressure Switch:
1. Function: Provide discrete indication of pressure
 2. Type: Machine Tool, NEMA 4, diaphragm actuated
 3. Range:
 - a. 3-150 psi nominal on decreasing pressure
 - b. 6-30 psi nominal adjustable differential
 4. 475 psig nominal maximum pressure
 5. Contacts: DPDT
 6. Manufacturer: Square-D or Allen-Bradley
- N. Intrinsic Safety Barrier:
1. Function: Interface control in explosive atmospheres
 2. Type: Solid state electronic
 3. Input Signal Value: Less than 1 VDC to field device
 4. Output Signal Value: 4-20 mADC to control system
 5. Approval: FM
 6. Manufacturer: Turck IM33-11Ex-HI/24VDC or approved equal
- O. Submersible Pressure Transducer/Transmitter:
1. Function: Provide analog pressure measurement
 2. Type: Pressure transducer with 4-20 mA output proportional to system pressure
 3. Wetted Parts: 316 Stainless steel
 4. Output: 4-20 mA
 5. Accuracy: 0.25%
 6. Manufacturer: KPSI/Esterline
- P. Panel Meters (Indicators):
1. Function: Provide visual indication of process variables

2. Type: 4-digit LCD with field selectable decimal point
 3. Adjustments: Field adjustable zero and span
 4. Housing: NEMA 4X
 5. Input: 4 to 20 maDC
 6. Power: 24 VDC loop powered
 7. Manufacturer: Precision Digital or approved equal
- Q. Signal Splitter:
1. Adjustments: Field adjustable zero and span
 2. Housing: NEMA 1
 3. Input: 4 to 20 maDC
 4. Output: 4 to 20 maDC
 5. Power: 24 VDC
 6. Manufacturer: Acromag, Adtech, or approved equal
- R. Ice Cube Relays (for use within PLC Panel and Valve Control Panel only):
1. Function: Relay logic
 2. Type: Heavy-duty plug in, with internal pilot light
 3. Contact Arrangement: 4PDT minimum, 10 amp rating
 4. Construction: Clear polycarbonate cover with epoxy encapsulated coil
 5. Mounting: Pin terminal-type socket
 6. Options: Pilot light, Time delay function (where applicable)
 7. Manufacturer: IDEC, Square-D, Allen-Bradley, General Electric, Cutler-Hammer, or approved equal
- S. Machine Tool Relays (for all use except within the PLC Panel and Valve Control Panel):
1. Function: Relay logic
 2. Type: Heavy-duty Machine Tool
 3. Contact Arrangement: 4PDT minimum, 10 amp rating, field convertible contacts
 4. Mounting: Relay mounting track, direct subpanel mount
 5. Options: Time delay function (where applicable)
 6. Manufacturer: IDEC, Square-D, Allen-Bradley, General Electric, Cutler-Hammer, or approved equal
- T. Circuit Breakers:
1. Function: Provide overcurrent protection
 2. Type: Molded-case. Provide voltage and amperage ratings as required
 3. Manufacturer: Square-D, or approved equal
- U. Uninterruptible Power Supply and Manual Bypass Switch:
1. Function: Provide back-up 120 VAC power.
 2. Type: On-line, double-conversion with fault tolerant auto-bypass
 3. Input: 120 VAC

4. Output: 120 VAC (minimum of six 5-15/20R receptacles)
 5. VA Output: As required to meet full load plus 20% spare capacity
 6. Runtime: Provide batteries as necessary for 1 hour of run-time at full load
 7. Communication: DB9 serial port (RS232 and contact closure supported)
 8. Bypass Switch: Manual bypass switch shall be make-before-break type.
 9. Manufacturer: Powerware (Eaton) Ferrups, Tripp-Lite (SmartOnline "SU" series) or approved equal
- V. Ethernet Switch:
1. Function: Provide connectivity between Ethernet devices
 2. Type: Unmanaged, 5 RJ45 ports, 10/100 MBit/s
 3. Power: 24 VDC
 4. Manufacturer: Sixnet, Phoenix Contact, Hirschmann, or approved equal
- W. Control Panel Power Surge Suppressor:
1. Function: Provide surge protection
 2. Type: 120 VAC, 1-phase, 3-wire, 10 kA
 3. Manufacturer: Emerson IE-120, EDCO model HSP121BT-1RU, Square-D model SDSA1175, or approved equal
- X. Digital Signal Surge Suppressor (for use on digital PLC inputs):
1. Function: Provide surge protection
 2. Type: 150 VAC, 1250 amp surge current MOV
 3. Manufacturer: Phoenix Contact TT-2/2-M-24VDC or approved equal
- Y. Analog Signal Surge Suppressor (for use on analog transmitters and analog PLC inputs):
1. Function: Dissipate electrical surge
 2. Type: Socket-mount
 3. Surge Rating: 10kA (8 x 20 microseconds), SAD hybrid technology
 4. Manufacturer: Phoenix Contact TT-2-PE-M-24VDC or approved equal
- Z. Ultrasonic Level Transmitter:
1. Service (s): Chemical storage tank storage level
 2. Measuring Range: 0 ft to 15 ft of liquid
 3. Accuracy: $\pm 0.2\%$ full scale
 4. Repeatability: $\pm 0.1\%$ full scale per year
 5. Response Time: 150 ms
 6. Pressure Range: N/A
 7. Temperature Range: Operating: 14° to 158°F (-10°C to 70°C)
 8. Storage: -40° to 176°F (-40°C to 80°C)
 9. Transmitter Type: Ultrasonic
 10. Output Signal: 4-20 mA
 11. Enclosure Rating: NEMA 4X (IP68)

12. Process Connections: Process flange on tank
 13. Power Supply: 120 VAC
 14. Materials: Sensor Housing: Kynar
 15. Acceptable Manufacturer: HydroRanger 200, manufactured by Siemens
- AA. Combustible Gas Element and Transmitter:
1. General:
 - a. Function: Continuously monitor ambient air for lower explosive limit (LEL) of combustible hydrocarbon based gases.
 - b. Sensor Type: Poison-resistant infrared type.
 - c. Parts: Element/transmitter, calibration kit, and ancillaries.
 2. Performance:
 - a. Range: 0 to 100 percent LEL.
 - b. Repeatability: +/- 1 percent of full scale.
 - c. Analog output accuracy: +/- 1 percent of full scale.
 - d. Long Term Drift (6 Months): Less than +/- 1 percent LEL.
 - e. Response Time: Less than 15 seconds.
 - f. Temperature (Operating): Element/Transmitter: - 40 degrees F to +200 degrees F.
 - g. Humidity, Operating (Both Element/Transmitter): 0 percent to 95 percent relative humidity, noncondensing.
 3. Element Sensor:
 - a. Number of Sensors: One.
 - b. Gas Monitored: Combustible gas.
 - c. Combustible Gas Sensor Type: Poison-resistant infrared type.
 - d. Enclosure: Suitable for NEC, Class 1, Division 1, Groups C and D hazardous areas.
 - e. Mount as follows: Wall mount.
 4. Transmitter:
 - a. Integral with element/sensor.
 - b. LCD Display.
 - c. Nonintrusive interface for functional, calibration, and alarm testing.
 - d. Enclosure: Explosion proof, suitable for Class 1, Division 1, Group C and Group D. Minimum of four-wire entry holes.
 - e. Mounting: Wall.
 - f. Signal Interface: 4 to 20 mA dc.
 - g. Power: 24 VDC, obtained from PLC Panel.
 5. Calibration System:
 - a. Zero and Span Adjustment: One remote control calibrator unit for calibration of all combustible gas sensors, without declassifying the area, and without opening the sensor enclosure.

- b. Calibration Check Kit: With all accessories, including cylinder of the gas being monitored.
- 6. Manufacturer and Product:
 - a. MSA Ultima X element/sensor
- 7. PLC Panel:
 - a. Panel shall be stainless steel or aluminum NEMA 4, totally enclosed one-piece design, pad-mounted and free-standing. Material shall be not less than 12 gage, reinforced and plug welded to angle frames. Construction incorporating a frame with light gage skin will not be acceptable. Panel shall have front access and be constructed by a UL listed panel manufacturer in strict compliance with NEMA and UL Standards.
 - b. The panel shall be factory assembled, wired, and tested. All wiring shall be neatly installed in horizontal and vertical runs. Terminals shall be so arranged to provide complete accessibility to all items.
 - c. Panel face openings for mounting equipment shall be smoothly finished cut with counter boring and trim strips provided as required to give a neat, finished appearance.
 - d. Enclosure doors shall be hinged with removable hinge pins. Each door shall incorporate a vault type handle with three-point latching mechanism for securing door in closed position, door locks shall be keyed alike. Only smooth rubber gasket material shall be used for providing door seal.
 - e. Joined edges, corners, and seams shall be of continuous bead weld (no filler or dubbing) and ground to a finish so as not to be detectable after painting. Spot welds shall be used only to connect flat metal surfaces to structural support bracing to provide rigidity. Care shall be taken to prevent warping of metal.
 - f. Inside surfaces shall be painted with a high-gloss white and the outside surface shall be painted with a color selected by the Owner.
 - g. Removable "eye" bolts shall be provided to facilitate slinging and handling of enclosures. "Eye" bolts shall be mounted directly to and be part of the enclosure structural members so as to distribute the stresses and enclosure weight while slinging.
 - h. Each floor standing-type panel shall be equipped with interior panel service lighting system and quadplex receptacle as a minimum.
 - i. Panel layout and equipment spacing shall be sufficient to allow for device removal and maintenance without disassembly of adjacent devices. Additionally, ample panel gutter space (sides, top, and bottom) shall be provided for training wires and cables.
 - j. Plastic wireway shall be used to route wires in all control panels and enclosures. Wireway fill shall not exceed 60 percent and shall be run in continuous lengths with snap-on type covers.
 - k. Each and every wire both internal and external to the panel shall be tagged at both ends with its respective wire number. Internal panel wiring will be No. 14 AWG, MTW 600 volts working, 1,500 volts test, Class C stranding with 2/64-inch minimum, 90° C insulation. All panel wiring not run in wire ducts shall be bundled and tied. Wire markers shall be provided at each wire termination point. All wires to internal components shall be connected to the "outside" of the terminal strip. No more than two wires shall be connected to any one terminal point.
 - l. Power wiring shall be black for hot and white for neutral. Control wiring shall be red for AC and blue for DC. Yellow wire shall be used on circuits which receive from two

sources not controlled by the panel disconnect. Green wire shall be used for ground. Shielded cable shall be black and white No. 16 AWG with aluminum mylar with bleed ground wire and provided with an overall PVC jacket.

- m. PLC digital input and output signals shall be fused protected using fused terminal blocks. PLC inputs shall be surge protected using the surge suppressors listed in the specification.
- n. The radio shall be mounted in the PLC panel.

PART 3 EXECUTION

4.01 INSTALLATION

- A. Installation of all equipment, materials, and components shall be by CONTRACTOR under the direct supervision of the manufacturer and as indicated on the Contract Drawings.

4.02 FIELD QUALITY CONTROL

- A. Testing on equipment, materials, and components herein specified shall be as specified in Section 40 90 00 - Process Instrumentation, Controls and Monitoring Equipment - General Requirements, Section 26 05 00 - Common Work Results for Electrical and Section 26 05 10 - Basic Electrical Materials and Methods.

4.03 ADJUSTMENTS

- A. Contractor shall make all adjustments necessary to place equipment, materials and components of the instrumentation and control systems in proper operating condition under normal operating and load conditions.
- B. The services of a factory trained, qualified service representative of the Equipment Manufacturer shall be provided to inspect the complete equipment installation to ensure that it is installed in accordance with the Contract Documents and manufacturer's recommendations, make adjustments necessary to place the system in trouble-free operation, and instruct the operating personnel in the proper care and operation of the equipment furnished.

4.04 CALIBRATION TEST EQUIPMENT/SPARE PARTS

- A. In order to maintain and calibrate the equipment, Contractor shall provide the following calibration and test equipment. This Specification covers the following equipment:
 - 1. Instrument Calibrator:
 - a. Function: Portable instrument to monitor and calibrate level control instrumentation. Measures volts, mA, RTD's, thermocouples, frequency, and ohms to test sensors and transmitters. Source/simulate volts, mA, thermocouples, RTD's, frequency, ohms and pressure to calibrate transmitters.
 - b. Indication: LCD readout.
 - c. Manufacturer: Fluke 789 Multifunction Process Calibrator or equal.

Function Measure or Source	Range	Resolution	Accuracy
Voltage	0 to 100mV 0 to 10 V (source) 0 to 30 V (measure)	0.01 mV 0.001 V 0.001 V	0.02% Rdg. +2 LSD
mA	0 to 24	0.001 mA	0.02% Rdg. +2 LSD
mV	-10.00 mV to +75.00mV	0.025% of range +1 LSD	
Resistance	0 Ω to 3200 Ω (measure)	0.01 Ω to 1.0 Ω	

	15 Ω to 3200 Ω (source)		
Frequency (source)	2.0 to 1000.0 CPM	0.1 CPM	$\pm 0.05\%$ of setting
	1 to 1000 Hz	1 Hz	$\pm 0.05\%$ of setting
	1.0 to 10.0 kHz	0.1 kHz	$\pm 0.25\%$ of setting
Frequency (measure)	1 CPM to 10 kHz	5 digits	0.05% Rdg +1 count
Loop Supply	24 V dc		10%

4.05 SPARE PARTS AND CONSUMABLES

- A. To minimize "down time," the following spare parts and consumables shall be turned over to Owner at time of start-up:
1. Spare Parts:
 - a. Contractor shall furnish as manufacturer's spare parts, 10 percent of the total used of each type of pilot light lamp, relay, push button of each type and head color furnished, and selector switches of each type furnished.

END OF SECTION

EXHIBIT 1

PROJECT FORMS

1. Certificate of Substantial Completion
2. Change Order
3. Change Proposal
4. Construction Change Requisition / Work Change Directive
5. Field Order
6. Non-Compliance Notice / Order to Remove Defective Work
7. Open Items List
8. Punch List Items
9. Request for Final Inspection
10. Request for Information
11. Substitution Request Form
12. Warranty Data Sheet

OWNER shall have 45 days after receipt of this certificate during which he may make written objection to ENGINEER and CONTRACTOR as to any provisions of the certificate or attached list. Such objection may be cause for this Certificate of Substantial Completion to be null and void.



CHANGE ORDER NO. _____

305.08
(Rev. 04/2019)

Prepared By: _____

Date of Issuance: _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

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

--

Attachments: (List documents supporting change):

--

CHANGE IN CONTRACT PRICE

Original Contract Price:

\$

Orders No. _____ from previously approved Change
to No. _____ :

\$

Contract Price prior to this Change Order:

\$

of this Change Order:

\$

Contract Price incorporating this Change Order:

\$

CHANGE IN CONTRACT TIME

Original Contract Times:

Working Days Calendar Days

Substantial Completion (date):

Ready for final payment (date):

Orders No. _____ from previously approved Change
to No. _____ :

Substantial Completion (days):

Ready for final payment (days):

Contract Times prior to this Change Order:

Substantial Completion (date):

Ready for final payment (date):

of this Change Order:

Substantial Completion (days):

Ready for final payment (days):

Contract Times with all approved Change Orders:

Substantial Completion (date):

Ready for final payment (date):

RECOMMENDED:

By: _____
Engineer (Authorized Signature)

Date: _____

ACCEPTED:

By: _____
Owner (Authorized Signature)

Date: _____

ACCEPTED:

By: _____
Contractor (Authorized Signature)

Date: _____

Change Order becomes effective upon date of final signature.



CHANGE PROPOSAL NO. _____

305.01
(Rev. 04/2019)

Prepared By: _____

Date of Issuance: _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

This Change Proposal is submitted in accordance with Paragraph 10.06 of the General Conditions.

If this Change Proposal is accepted, either in whole or in part, a Change Order will be issued to modify the Contract Documents accordingly.

Detailed Description of Proposed Change:

Attachments: (List documents attached supporting requested change):	
<p><u>CHANGE IN CONTRACT PRICE</u> of this requested Proposal:</p> <p>\$ _____</p>	<p><u>CHANGE IN CONTRACT TIME</u> of this requested Change Proposal:</p> <p>Substantial Completion (days): _____ Ready for final payment (days): _____</p>

Engineer's Decision on Change Proposal:

<p>ENGINEER:</p> <p>By: _____ <i>Engineer (Authorized Signature)</i></p> <p>Date: _____</p>	<p>OWNER:</p> <p>By: _____ <i>Owner (Authorized Signature)</i></p> <p>Date: _____</p>	<p>CONTRACTOR:</p> <p>By: _____ <i>Contractor (Authorized Signature)</i></p> <p>Date: _____</p>

CONSTRUCTION CHANGE REQUISITION WORK CHANGE DIRECTIVE



CONSTRUCTION CHANGE REQUISITION WORK CHANGE DIRECTIVE

No. _____

(continued)

Date: _____

Page: _____ of _____

Work Order Authorization: Approved Approved as Noted Not Approved

If authorized, the Contractor agrees to do the work outlined above under the direction of the Engineer, and to accept as payment in full the basis of payment as indicated.

Contract Time: Add Time Extension of _____ Days Not Applicable

Accepted By: _____
Contractor (Representative) _____ Date _____

Recommended By: _____
Wade Trim (Representative) _____ Date _____

Approved By: _____
Owner (Representative) _____ Date _____



FIELD ORDER NO. _____

305.04
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	
Date:			
Prepared by:			
Subject / Description:			

Classification:	Clarification or Interpretation of Contract Documents
-	Minor Change in Work Which Does Not Involve Contract Price or Contract Time
	Minor Change in Addition to Work

Reason:_____
Resident Project Representative Date_____
Contractor's Authorized Representative Date



NON-COMPLIANCE NOTICE / ORDER TO REMOVE DEFECTIVE WORK NO. _____

330.06
(Rev. 01/2018)

Job No.: _____

Date: _____

Project: _____

Time: _____

Attention: _____

You are hereby notified that:

_____ does not conform to the Contract Requirements. The Specification violated in Section _____, Article _____, Drawing No. _____. Under the provisions of the Contract, the requirements are _____

Non-complying work may be required to be removed and replaced at no cost to the Owner.

Non-complying work may be removed and replaced at no cost to the Owner. No work shall continue until the defective work has been removed.

It shall be the Contractor's responsibility to determine the corrective action plan necessary to bring the work into compliance. This action plan shall be submitted to the Owner and his authorized representative for their review and concurrence that said corrective action will adequately address the deficiency. If you refute the initial findings, it is your responsibility to make your position known to the Owner and his representative with sufficient documentation that your position can be evaluated. All actions described above shall be done in writing as near to the date of the Notice as possible, but no later than ten (10) days after the issuance of said Notice.

Resident Project Representative (Signature)

Non-Compliance Notice Received By Contractor

Received On: _____
Date

By: _____
(Signature)

Title: _____

Corrective action to be taken by Contractor: _____

Date

By: _____
(Signature)

Owner's Acknowledgement

Accepted

Accepted as Noted

Unacceptable

Pricing

Date

By: _____
(Signature)

OPEN ITEMS LIST

350.01

(Rev. 01/2019)

Page: of

Construction Start Date: _____

WT Project No.:		Project Name:			
Owner / Municipality:					
Owner Project No.:		Department:			
Project Location:					
Contractor:			Subcontractor:		

[illegible]

Close out of all items verified by Field Engineer: _____ **Signature:** _____ **Date:** _____

Comments:

- 1) This Open Items List is to be immediately inserted in the Inspection folder for each assignment by the assigned Inspector or the assigned Field Engineer.
- 2) Anyone can make entries on this list, but each entry must be initialed and dated. Item(s) entered must be reported to the assigned Field Engineer immediately.
- 3) Action to be taken should be confirmed with the assigned Field Engineer.
- 4) Verification for completion can be initialed and dated by the assigned Inspector but must also be verified by the assigned Field Engineer.
- 5) This form is not contractual to contract completion.



REQUEST FOR FINAL INSPECTION

350.06
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

The project to which this request applies has been inspected by authorized representatives of CONTRACTOR and ENGINEER, and the Work is hereby declared to be substantially complete to a point that a project punch list should be prepared in accordance with the following schedule:

Develop Preliminary Punch List**Date:** _____

Responsibility: Owner, Contractor and Engineer
Engineer shall have 2 weeks to prepare the punch list.

Complete Preliminary Punch List Items**Date:** _____

Responsibility: Contractor
Contractor shall have 2 weeks to complete the items on the punch list.

Develop Final Punch List (if needed)**Date:** _____

Responsibility: Owner, Contractor and Engineer
If needed, a second and final punch list will be prepared within 2 weeks by Engineer.

Complete Final Punch List Items**Date:** _____

Responsibility: Contractor
Contractor shall have 2 weeks to complete the items on the second and final punch list.

Process Final Payment**Date:** _____

Engineer will have 2 weeks to review and submit final pay request documents from Contractor to the Owner for final payment upon satisfactory completion of punch list items by Contractor.

This notice signed and dated through mutual agreement of CONTRACTOR and ENGINEER will initiate the time sequence for the approved execution of finalizing _____

Contract in _____, Michigan, dated _____.

COPY: OWNER

Date: _____

ENGINEER's Representative

Date: _____

CONTRACTOR's Representative

[Contractor to
Insert logo here]

REQUEST FOR INFORMATION (RFI) NO. _____

311-01
(Rev. 04/2019)

Page: 1 of

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

RFI Subject:			
Division:		Spec Section:	
Plan Sheet No(s).:			
Date Received:		Requested Response Date:	
Returned to Contractor:			

Is there potential for effects to the Contract?

Contract Price Impact:

Contract Schedule Impact:

Information Requested

Attachments

Response**Attachments**

Response by: _____ Date: _____

THIS REPLY IS GIVEN WITH THE EXPRESSED UNDERSTANDING THAT IT DOES NOT CONSTITUTE BASIS FOR CHANGE IN PRICE OR TIME OF THE CONTRACT UNLESS OTHERWISE INDICATED.



REQUEST FOR INFORMATION (RFI) NO. _____ RESPONSE

311-01
(Rev. 04/2019)

Page: 1 of _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

RFI Subject:			
Division:		Spec Section:	
Plan Sheet No(s).:			
Date Received:		Requested Response Date:	
Returned to Contractor:			

REVIEWER INFORMATION

Reviewed By:	
Email:	
Phone:	

RESPONSE:

Attachments

Response by: _____ Date: _____

THIS REPLY IS GIVEN WITH THE EXPRESSED UNDERSTANDING THAT IT DOES NOT CONSTITUTE BASIS FOR CHANGE IN PRICE OR TIME OF THE CONTRACT UNLESS OTHERWISE INDICATED.



SUBSTITUTION REQUEST FORM

310.06
(Rev. 04/2019)

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	

Specification Section: _____ Article No.: _____
Specified Product: _____
Proposed Substitution: _____

Does specified product exceed in any respect, proposed substitution?	Yes	No
Does substitution affect dimensions shown on Plans?	Yes	No
Does substitution affect other trades more than original product?	Yes	No
Does warranty differ from that specified?	Yes	No
Does substitution affect cost to OWNER?	Yes	No
Does substitution result in any license fee or royalty?	Yes	No

If you indicated "Yes" to any of the items above, attach thorough explanation for the following:

1. Explain any differences between proposed substitution and specified product.
2. Summarize experience with product and manufacturer in Project area.
3. Attach complete technical data and literature.

The undersigned states that the function, appearance, and quality of the proposed substitution is equivalent or superior to the specified item, and that all information above and attached is true and correct.

Submitted by: _____ Date Submitted: _____
Company: _____
Address: _____
Telephone: _____ Email: _____
Signature: _____

ACTION STATUS	
ENGINEER'S REVIEW	RESPONSE REQUIRED OF CONTRACTOR
1. Approved (A) 2. Approved as Noted (AN) 3. Revise and Resubmit (RR) 4. Not Approved - See Remarks (NA)	None Confirm Resubmit
<p>Engineer's review is for general conformance with the design concept and contract documents. Markings or comments should not be construed as relieving the contractor from compliance with the project requirements, nor departures therefrom. The contractor remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of assembly, and for performing his work in a safe manner.</p> <p>WADE TRIM</p> <p>By: _____ Date: _____</p>	



WARRANTY DATA SHEET

350.07
(Rev. 04/2019)

Date: _____
Page: _____ of _____

WT Project No.:		Project Name:	
Owner / Municipality:			
Owner Project No.:		Department:	
Project Location:			
Contractor:		Subcontractor:	
Contractor Address:		Phone:	

Project Description:

Supplier/Vendor: _____ Phone: _____
Address: _____

Manufacturer: _____ Serial No. _____

Manufacturer Part No.: _____ Asset / Part Name: _____

Location: _____ Owner ID No.: _____

Warranty Provider: _____

Warranty Type (labor, parts, parts and labor, etc.) _____

Warranty Description:

Warranty Class/Limitations: Limited 1 year 2 year
Other: _____

Warranty Date: _____ Initial Reading: _____

Warranty Expiration Date: _____ Maximum Reading: _____

Exclusions:

Comments:

Attachment: Copy of Warranty

EXHIBIT 2

PROJECT REPORTS & PROPOSALS

1. MAK Controls Proposal

City of Flint
Flint, Michigan
Secondary Clarifier Battery B

Flow Control
MAK-2307

MAK: Michael Lancina
MAKcontrolsLLC@gmail.com
(734) 770-8785

WadeTrim: Trevor Wagenmaker
twagenmaker@wadetrim.com
(810) 235-2555



ELECTRICAL ENGINEERING | CONTROLS DESIGN
PANEL FABRICATION | PROJECT MANAGEMENT

MAK-2307 Secondary Clarifier System Features & Functions



Scope

Provide a budgetary estimate of engineering to support the proposed new Clarifier flow controls.

Justification

The existing flow control to the Battery B clarifiers 5, 6, 7, and 8 is no longer functioning.

Flow meters and control valves will be replaced (by others).

Existing I/O will be reused for the RAS metering/control. A new remote I/O panel will be required for the Influent meters and valves in the Clarifier vault.

Description

In general, system commissioning support and engineering support during construction will be provided as necessary.

A new remote I/O panel will be supplied. It will support the new flow meters and valves for Influent control and will be located above the Clarifier vault.

The new panel will require a Fiber connection to the plant ethernet network. There is a fiber drop in the equipment building.

Flow loops for Influent and RAS will be configured and tuned. These flow loops interact with the final tank level.

Existing graphics will be updated and expanded to support the modified control scheme.

System generated Alarms/Events will be ported into the plant HMI.

Installation by others.

Payment Terms

The following is a budgetary proposal for this project:

\$26,155.00

MAK-2307 Secondary Clarifier Bill of Materials



Qty	Item	Manufacturer	Description
1	Enclosure for Remote I/O Panel	SCE	16" x 20" x 8", NEMA 4x
1	Enclosure Subpanel	SCE	Subpanel, Bent
2	Ethernet Switch	Phoenix Contact	Fiber-Optic & 4-port ethernet switch
1	Power Supply, 24vdc	PULS	Power Supply 100w 24vdc
5	Point I/O Base	Allen-Bradley	Point I/O Base
1	Point I/O Module, DI	Allen-Bradley	Digital Input, 4 point
3	Point I/O Module, AI	Allen-Bradley	Analog Input, 4 point
1	Point I/O Module, AO	Allen-Bradley	Analog Output, 4 point
1	Point I/O Ethernet/IP Scanner	Allen-Bradley	Ethernet/IP Interface
Misc. Hardware			
1	CCS Services Calc	MAK Controls	engineering services
Engineering Services			

MAK-2307 Secondary Clarifier Terms and Conditions



The terms and conditions stated below shall become a part of any service agreement or contract including services by MAK Controls LLC (hereinafter "MAK Controls")

1. COMPENSATION:

Unless otherwise agreed to by MAK Controls, the Purchaser will pay MAK Controls for services rendered which shall be invoiced at the hourly rates applicable to the type of service(s) provided by the MAK Controls employee(s) during the billing period. Services shall include the travel spent to Purchaser's place of business from the office or home of the MAK Controls employees. Purchasers shall reimburse MAK Controls for reasonable out of pocket expenses as defined in Section 8. Payments must be made in full within 30 days of the dates of the invoices.

2. TAXES AND OTHER CHARGES:

The Purchaser shall pay MAK Controls an additional amount equal to any taxes, duties or charges by any governmental or quasi-governmental authority which accrues due to this contract except for taxes on net income.

3. SCOPE CHANGES:

Any changes in the scope of order other than for services or any material change in the scope of an order for services must be documented in writing by the Purchaser and subject to incorporation in the original agreement by written approval by an Officer of MAK Controls. Any of these changes authorized by Purchaser may result in price, delivery and/or condition changes. Price changes shall be on the then current rates.

4. NORMAL WORK DAY:

The normal workday shall be an eight (8) hour day shift excluding Saturdays, Sundays and holidays observed by MAK Controls.

5. OVERTIME:

Any service or travel not performed or done during a normal workday shall be invoiced at MAK Controls's overtime rate only when agreed to by Purchaser.

6. SHIFT WORK:

When shift work (eight (8) hour shifts other than the normal work day) is required, a twenty percent (20%) premium shall be added for service during the other shifts. Overtime rates plus twenty percent (20%) shall be applicable for work in excess of eight (8) hours during these other shifts.

7. ADVANCED COMMITMENTS:

Service time committed in advance by MAK Controls on the basis of a pre-specified number of days shall not be deemed to include overtime or shift work. If overtime or shift work is required on such commitments, the pre-specified time so committed in advance shall be appropriately reduced.

8. EXPENSES:

Unless otherwise agreed upon in writing, Purchaser shall reimburse MAK Controls for expenses as follows:

- A. Automobile travel expenses shall be reimbursed on the basis of the current IRS approved standard mileage rate.
- B. All other travel and living expenses shall be reimbursed at cost.
- C. Applicable communication expense accrued on the job shall be reimbursed at cost.

Travel time and expenses shall accrue from the point of origin. Airline travel shall be at Coach class unless Purchaser's needs versus seat availability dictates otherwise. Living accommodations shall be of business class quality unless unavailable in which case the next best available accommodations shall be selected.

9. DELAYS

Unless the MAK Controls representative has been released from the jobsite, or has completed his assignment, the Purchaser will pay MAK Controls charges computed as if the MAK Controls representative was working a normal work week, regardless of whether or not the representative is prevented from working due to delays beyond this control. Release from the jobsite shall entitle the representative to return to his point of origin, with travel time and expenses for the account of Purchaser.

10. STANDBY TIME:

Standby time is defined as the time during which a MAK Controls representative is requested to remain in readiness and available for work commencing at the convenience of the Purchase. Such time shall be considered as time worked, whether or not the representative is at the jobsite, and Purchaser will be billed accordingly. If standby time is outside normal working hours, overtime rates will be applicable. Standby time will be added to time actually worked for the computation of overtime charges, etc.

11. WORKING CONDITIONS:

The MAK Controls representative reserves the right to refuse to work under hazardous conditions. In case of doubt, mutual agreement must be reached prior to commencement of any work. All staging and rigging required for access to equipment to be serviced shall be erected by and at the expense of others and shall comply with reasonable safety requirements. The MAK Controls representative shall comply with all plant regulations where applicable. However, any clothing or equipment, except the standard safety hat, safety glasses, safety shoes, and nomex coveralls, shall be provided by Purchaser.

12. LIMITATION OF LIABILITY:

MAK Controls representatives are authorized to act only in a consulting capacity and are not authorized or licensed to operate equipment. All responsibility for operating equipment shall rest with others. Except as provided in Paragraph 14, MAK Controls shall not be liable for loss or damage of any nature.

13. TOOLS AND TEST EQUIPMENT:

The MAK Controls representative will be equipped with instruments, tools and test equipment as required to fulfill service obligations.

14. INSURANCE INDEMNITY:

MAK Controls will at Purchaser's request submit Certificates of Insurance from Sureties chosen by MAK Controls showing the limits of coverage. MAK Controls agrees to indemnify and save harmless Purchaser only against liability imposed on Purchaser by law with respect to bodily injury or property damage to the extent such liability results from the performance of MAK Controls under this contract. MAK Controls does not agree to indemnify and save Purchaser harmless except as set forth herein. Purchaser agrees to indemnify and save harmless MAK Controls for all loss, cost or damage incurred by MAK Controls as a result of Purchaser's or third party's misuse of misapplication of MAK Controls's supplied products. IN NO EVENT, REGARDLESS OF CAUSE, SHALL MAK Controls BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE EITHER REAL OR ALLEGED.

15. MISCELLANEOUS: