CONTRACT DOCUMENTS

WPC Third Avenue Pumping Station Improvements

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

June 2021

COF107301F

PREPARED BY:





P.O. Box 824 Bloomfield Hills, MI 48303



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Division 00 Procurement and Contracting Requirements

Section 00 2213 Supplementary Instructions to Bidders

Part 1 General

1.01 American Iron and Steel Requirements

- A. CONTRACTOR acknowledges to and for the benefit of the City of Flint ("Purchaser") and the Michigan Department of Environmental Quality (the "State") that it understands the goods and services under this Agreement are being funded with monies made available by the State Revolving Fund and/or the Drinking Water Revolving Fund and such law contains provisions commonly known as "American Iron and Steel (AIS);" that requires all iron and steel products used in the project be produced in the United States ("AIS Requirements") including iron and steel provided by CONTRACTOR pursuant to this Agreement.
- B. CONTRACTOR hereby represents and warrants to and for the benefit of the Purchaser and the State that:
 - 1. CONTRACTOR has reviewed and understands the AIS Requirements:
 - 2. all iron and steel used in the project will be and/or have been produced in the United States in a manner that complies with the AIS Requirements, unless a waiver of the requirements is approved or the State made the determination in writing that the AIS Requirements do not apply to the project, and
 - 3. CONTRACTOR will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the AIS requirements, as may be requested by the Purchaser.
- C. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by CONTRACTOR shall permit the Purchaser or State to recover as damages against CONTRACTOR any loss, expense or cost (including without limitation attorney's fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser).
- D. While CONTRACTOR has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and CONTRACTOR agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give these paragraphs force or effect) shall be amended or waived without the prior written consent of the State.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 00 4243 Proposal

City of Flint 1101 S. Saginaw Street Flint, Michigan 48502

Re: WPC Third Avenue Pumping Station Improvements

The undersigned Bidder proposes and agrees, if this Proposal is accepted, to enter into an Agreement with the City of Flint (OWNER) 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 this Bid and in accordance with the Contract Documents.

In submitting this Proposal, Bidder represents, as more fully set forth in the Agreement, that;

a) Bidder has examined copies of all Contract Documents which he understands and accepts as sufficient for the purpose, including any and all Addenda officially issued, the receipt of which is hereby acknowledged.

| Addendum No. | Date of Release | Signature |
|--------------|-----------------|-----------|
| | | |
| | | |

- b) 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.
- c) This 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 OWNER.
- d) Specified cash allowances shall be included in the Total Base Contract Price and have been computed in accordance with Article 12.02 of the General Conditions. Allowances for the specified Work include:
 - 1. SCADA programming and process integration in the amount of \$12,000 in accordance with the proposal dated May 26, 2021 by MAK Controls (Exhibit 2).
 - 2. An Owner-Controlled Contingency Allowance in the amount of \$500,000.00.

The Bidder agrees to complete the Work, in accordance with the Contract Documents, for the following Contract Price:

Improvements to the Third Avenue Pumping Station

TOTAL BASE CONTRACT PRICE

\$_____(numeric)

(In Words)

The following unit prices are given based on the work pertaining to the scope as given on the Drawings. All prices are to be included in the Total Base Contract Price set forth above. Final quantities will be determined during construction as given in Paragraph 12.03 of the General Conditions.

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|------|----------------------|----------|------|------------|--------------------|
| A1 | Brick Repointing | 560 | LF | \$ | \$ |
| A2 | Limestone Repointing | 110 | LF | \$ | \$ |

The undersigned, as Bidder, hereby certifies that he or a qualified designated person in his employ has examined the Contract Documents provided by OWNER for bidding purposes. Further, the undersigned certifies that he or his qualified employee has reviewed the Bidder's proposed construction methods and finds them compatible with the conditions and from the information provided for Bidding.

The undersigned, as Bidder, shall complete the Work under any job circumstances or field conditions present and/or ascertainable prior to bidding. In addition, he shall also complete the Work under whatever conditions he may create by his own sequence of construction, construction methods, or other conditions he may create, at no additional cost to OWNER.

The undersigned, as Bidder, declares that he has familiarized himself with the location of the proposed Work and the conditions under which it must be constructed. Also, that he has carefully examined the Plans, the Specifications, and the Contract Documents, which he understands and accepts as sufficient for the purpose and agrees that he will Contract with OWNER to furnish all labor, material, tools, and equipment necessary to do all Work specified and prescribed for the completion of the Project.

The undersigned agrees, 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.

The undersigned agrees that time is of the essence and, if awarded Contract, that the Work will be Substantially Completed within Four Hundred Twenty (420) calendar days after the Notice to Proceed has been issued and completed within Four Hundred and Eighty (480) calendar days of the Notice to Proceed has been issued.

Liquidated damages, as specified in the General Conditions, Supplementary Conditions and Agreement, shall also apply to the above Substantial Completion date.

Engineering and inspection costs incurred after the above final completion date shall be paid by CONTRACTOR to OWNER as specified in the Conditions of the Contract and Agreement.

Proposals may not be withdrawn for a period of one hundred twenty (120) days after bid opening.

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

| a) | Required Bid security in the form checked below: | | | | |
|----|--|-------------|----------|-------------|--------------|
| | Certified Check | Cashier's | Check | Money Order | 🗌 Bid Bond |
| b) | Legal Status of Bidder. | | | | |
| c) | Bidder's Name: | | | | |
| | Ву: | (Cignature) | | (D | vinted Name) |
| | Address: | (Signature) | | (1* | nintea Namej |
| | Phone No. | | Fay No. | | |
| | Email: | | rax no.: | | |
| | | | | | |

Section 00 4313 Bid Bond Form

| KNOW ALL BY THESE PRESENTS, that we, the undersigned, | | |
|---|--|--|
| as Principal, hereinafter called the Principal, and | | |
| 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 City of Flint, 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 | | |

NOW, THEREFORE, if OWNER shall accept the Bid of the Principal and the Principal shall enter into a Contract with 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 OWNER the difference not-to-exceed the penalty hereof between the amount specified in said Bid and such larger amount for which 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 |
|------------------------|--------|------|
| 0 | | |

(Witness)

(Principal)

(Title)

(Witness)

(Surety)

(Title)

Section 00 4345 Legal Status of Bidder

This Proposal is submitted in the name of:

| (Print) | |
|---------------|---|
| The undersigr | ned hereby designates below his business address to which all notices, directions or other |
| communicatio | ons may be served or mailed: |
| Street | |
| City | |
| State | Zip Code |
| The undersigr | ed hereby declares that he has legal status checked below: |
| | SOLE PROPRIETOR |
| | SOLE PROPPRIETOR DOING BUSINESS UNDER AN ASSUMED NAME |
| | CU-PARTNERSHIP The Assumed Name of the Co-Partnership is registered in the County of |
| | Michigan |
| | CORPORATION INCORPORATED UNDER THE LAWS OF THE STATE OF The Corporation is |
| | authorized to conduct business in the State of Michigan not now authorized to conduct business in the State of Michigan 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 AND TITLE | HOME ADDRESS |
|--------------------|------------------------|
| | |
| | |
| Signed this day of | , 20 |
| | By (Signature) |
| | Printed Name of Signer |
| | Title |
| | |

Section 00 4546.13 Certification Regarding Debarment, Suspension and Other Responsibility Matters

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

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

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

Name and Title of Authorized Representative

Name of Participant Agency or Firm

Signature of Authorized Representative

Date

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

Section 00 4539.13 Disadvantaged Business Enterprise (DBE)

Part 1 General

1.01 Summary

- A. Prime contractors bidding on this project must follow, document, and maintain documentation of their Good Faith Efforts, as listed below, to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach. Bidders must make the following Good Faith Efforts for any work that will be subcontracted.
 - 1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. Place DBEs on solicitation lists and solicit DBEs whenever they are potential sources.
 - 2. Make information on forthcoming opportunities available to DBEs. Arrange timeframes for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date. The DBEs should be given a minimum of 5 days to respond to the posting.
 - 3. Consider in the contracting process whether firms competing for large contracts can be subcontracted with DBEs. Divide total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
 - 4. Encourage contracting with a consortium of DBEs when a contract is too large for one DBE firm to handle individually.
 - 5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.
- B. Subsequent to compliance with the Good Faith Efforts, the following conditions also apply under the DBE requirements. Completed Good Faith Efforts Worksheets (Attachment 1), along with the required supporting documentation outlined in the instructions, must be submitted with your bid proposal. EPA form 6100-2 must also be provided at the pre-bid meeting. A copy of this form is available on the Forms and Guidance page of the Revolving Loan website.
 - 1. The prime contractor must pay its subcontractor for work that has been satisfactorily completed no more than 30 days from the prime contractor's receipt of payment from the owner.
 - 2. The prime contractor must notify the owner in writing prior to the termination of any DBE subcontractor for convenience by the prime contractor and employ the Good Faith Efforts if soliciting a replacement contractor.

If a DBE contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the Good Faith Efforts if soliciting a replacement contractor.

3. The prime contractor must employ the Good Faith Efforts.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

See next page for Attachment 1, Instructions, Frequently Asked Questions and DBE Subcontractor Participation Form.

Attachment 1

Michigan Department of Environmental Quality Office of Drinking Water and Municipal Assistance- Revolving Loan Section **Disadvantaged Business Enterprise (DBE) Utilization** State Revolving Fund/Drinking Water Revolving Fund **GOOD FAITH EFFORTS WORKSHEET**

Bidder: _____

Subcontract Area of Work (one per worksheet: ______

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

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

| Company Name | Type of Contact | Date of Contact | Price Quote Received | Accepted/ Rejected | Please Explain if Rejected |
|--------------|--------------------|--------------------|-------------------------|-----------------------|-------------------------------|
| | | | | □ A □ R | |
| | | | | □ A □ R | |
| | | | | □ A □ R | |
| | | | | □ A □ R | |
| | | | | □ A □ R | |
| | | | | □ A □ R | |

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

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

Other Efforts (attach extra sheets if necessary): _____

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

Authorized under Parts 43 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

www.michigan.gov/deq

Michigan Department of Environmental Quality Office of Drinking Water and Municipal Assistance- Revolving Loan Section Disadvantaged Business Enterprise (DBE) Utilization State Revolving Fund/Drinking Water Revolving Fund GOOD FAITH EFFORTS WORKSHEET

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

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

Rev. 3-2015

Authorized under Parts 43 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Disadvantaged Business Enterprise (DBE) Requirements Frequently Asked Questions Regarding Contractor Compliance

- Q: What is the Good Faith Efforts Worksheet form and how is it to be completed?
 - A: This form captures efforts by the prime contractor to solicit DBEs for each area of work type that will be subcontracted out. A separate Good Faith Efforts Worksheet must be provided by the prime contractor for each area of work type to be subcontracted out. There are specific instructions that accompany this form that prescribe minimum efforts which bidders must make in order to be in compliance with the DBE requirements.
- Q: Can non-certified DBEs be used?
 - A: While non-certified DBEs can be used, only DBEs, MBEs, and WBEs that are certified by EPA, SBA, or MOOT (or by tribal, state and local governments, as long as their standards for certification meet or exceed the standards in EPA policy) can be counted toward the fair share goal. Proof of certification by one of these recognized and approved agencies should be sought from each DBE.
- Q: How does a DBE get certified?
 - A: Applications for certification under MOOT can be found at http://mdotjboss.state.mi.us/UCP/LearnHowServ1et

Applications for certification under EPA can be found on EPA's Small Business Programs website at <u>http://www.epa.gov/osbp/dbe_firm.htm</u> under Certification Forms.

- Q: If a bidder follows the MOOT DBE requirements, will the bidder be in compliance with the SRF/DWRF DBE requirements?
 - A: No. Federally funded highway projects utilize DBE goals, which require that a certain percentage of work be performed by DBE subcontractors. For SRF/DWRF projects there is no financial goal. However, there is a solicitation effort goal. Bidders must use Good Faith Efforts for each and every area of work to be subcontracted out to obtain DBEs. The bidders are not required to use DBEs if the quotes are higher than non-DBE subcontractors. There is no required DBE participation percentage contract goal for the SRF/DWRF. However, if the SRF/DWRF project is part of a joint project with MOOT, the project can be excluded from SRF/DWRF DBE requirements (i.e., the Good Faith Efforts Worksheet is not required) as it would be difficult to comply with both programs' requirements.
- Q: Must the Good Faith Efforts Worksheet and supporting documentation be turned in with the bid proposals?
 - A: Yes. This is a requirement to document that the contractor has complied with the DBE requirements and the Good Faith Efforts. These compliance efforts must be done during the bidding phase and not after-the-fact. It is highly recommended that the need for these efforts and the submittal of the forms with the bid proposals be emphasized at the pre-bid meetings. Failure to show that the Good Faith Efforts were complied with during the bidding process can lead to a prime contractor being found non-responsive.
- Q: Does EPA form 6100-2 need to be provided at the pre-bid meeting?
 - A: Yes. The form must be made available at the pre-bid meeting.
- Q: What kinds of documentation should a contractor provide to document solicitation efforts?
 - A: Documentation can include fax confirmation sheets, copies of solicitation letters/e-mails, printouts of online solicitations, printouts of online search results, affidavits of publication in newspapers, etc.

- Q: How much time will compliance with the Good Faith Efforts require in terms of structuring an adequate bidding period?
 - A: Due to the extent of the efforts required, a minimum of 30 calendar days is recommended between bid posting and bid opening to ensure adequate time for contractors to locate certified DBEs and solicit quotes.
- Q: How does a contractor locate certified DBEs?
 - A: The Michigan Department of Transportation has a directory of all Michigan certified entities located at <u>http://mdotjboss.state.mi.us/UCP/</u>. Additionally, the federal System for Award Management (SAM) is another place to search and can be found at <u>www.sam.gov</u>. SAM contains information from the former Central Contractor Registration (CCR) database.
- Q: If the bidder does not intend to subcontract any work, what forms, if any, must be provided with the bid proposal?
 - A: The bidder should complete the Good Faith Efforts Worksheet with a notation that no subcontracting will be done. However, if the bidder is awarded the contract and then decides to subcontract work at any point, then the Good Faith Efforts must be made to solicit DBEs.
- Q: In the perfect world, the Good Faith Efforts Worksheet is required to be turned in with the proposal. What if no forms are turned in with the bid proposal or forms are blank or incomplete? Should this be cause to determine that the bidder is non-responsive?
 - A: While the Good Faith Efforts Worksheet is important, it is more critical to confirm that the contractor complied with the DBE requirements prior to bid opening. The owner should contact the bidder as soon as deficiencies are noted for a determination/documentation of efforts taken to comply with the DBE requirements, Immediate submittal of the completed forms will be acceptable provided the Good Faith Efforts were made and it is just a matter of transferring information to the forms.

Section 00 5100 Notice of Award

| То: | | | |
|-----|--|--|--|
| | | | |

Date: _____, 20____

Project: WPC Third Avenue Pumping Station Improvements

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 \$_____ ()____. This project shall consist of improvements to the Third Avenue Pumping Station including building improvements in the form of brick repair, roof replacement and new windows; removal and replacement of a 60-inch diameter isolation valve with a new 60-inch diameter knife gate and coupling, including an electric motor actuator; removal of an existing wet weather pump with an 18-mgd dry-pit submersible pump for dry weather, including piping, fittings, valves, variable frequency drive, instrumentation and controls. Work will also include replacing two existing valves at the WPCF with two new valves – a 72-inch and a 50-inch knife gate – including a new valve vault structure and appurtenances. Work at both the Third Avenue Pumping Station and the WPCF will require temporary line stops; bypass pumping up to 50 mgd will be required at the Third Avenue Pumping Station, as delineated in your Bid submitted to the _______ on ______.

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 OWNER when executed by him.

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 the ENGINEER the required schedules prior to the scheduling of a Pre-Construction Meeting.

| Copy to ENGINEER: |
|--------------------------|
| Wade Trim. Inc. |

555 S. Saginaw Street, Suite 201 Flint, MI 48502 (OWNER)

By: ____

(Authorized Signature)

NOTICE OF AWARD

Section 00 5200 Agreement

This Agreement, made and entered into this _____ day of _____ in the year 20_____ by and between the City of Flint hereinafter called OWNER, and ______

______ hereinafter called CONTRACTOR, in consideration of the mutual covenants hereinafter sent forth, agree as follows:

ARTICLE 1. WORK

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

Improvements to the Third Avenue Pumping Station including building improvements in the form of brick repair, roof replacement and new windows; removal and replacement of a 60-inch diameter isolation valve with a new 60-inch diameter knife gate and coupling, including an electric motor actuator; removal of an existing wet weather pump with an 18-mgd dry-pit submersible pump for dry weather, including piping, fittings, valves, variable frequency drive, instrumentation, controls and SCADA programming. Work will also include replacing two existing valves at the WPCF with two new valves – a 72-inch and a 50-inch knife gate – including a new valve vault structure and appurtenances. Work at both the Third Avenue Pumping Station and the WPCF will require temporary line stops; bypass pumping up to 50 mgd will be required at the Third Avenue Pumping Station.

ARTICLE 2. CONTRACT TIME

- 2.1 The Work will be substantially completed within **three-hundred thirty-five (335) calendar days** after the Notice to Proceed has been issued and completed and ready for final payment in accordance with paragraph 14.11 of the General Conditions within **three-hundred sixty-five (365) calendar days** after the Notice to Proceed has been issued.
- 2.2 Engineering and inspection costs incurred after the specified final completion date shall be paid by CONTRACTOR to OWNER prior to final payment authorization. Charges 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. The costs incurred by ENGINEER after the specified final completion date shall be deducted from CONTRACTOR's progress payments.
- 2.3 Liquidated Damages. OWNER and CONTRACTOR recognize that time is of the essence of this Agreement and that OWNER will suffer financial loss if the Work is not Substantially Complete within the time specified in Article 2.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not Substantially Complete on time.
- 2.4 Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as penalty) CONTRACTOR shall pay **Two Thousand Five Hundred Dollars (\$2,500.00)** to OWNER for each day that expires after the time specified in Article 2.1 for Substantial Completion until the Work is Substantially Complete. Liquidated damages charged shall be deducted from CONTRACTOR's progress payment.

ARTICLE 3. CONTRACT PRICE

3.1 OWNER shall pay CONTRACTOR as provided in the attached Proposal for performance of the Work in accordance with the Contract Documents.

ARTICLE 4. PAYMENT PROCEDURES

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:

- 4.1 The person representing CONTRACTOR who will submit written requests for progress payments shall be: ______
- 4.2 The person representing OWNER to whom requests for progress payments are to be submitted shall be: ______
- 4.3 CONTRACTOR's representative, listed above, shall submit Applications for Payment on the form provided in the Contract Documents in accordance with Article 14 of the General Conditions. Applications for Payment will be processed as provided in the General Conditions.

ARTICLE 5. CONTRACTOR'S REPRESENTATIONS

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations:

- 5.1 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.
- 5.2 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.
- 5.3 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 Article 5.2 as he 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 CONTRACTOR for such purposes.
- 5.4 CONTRACTOR has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.
- 5.5 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 CONTRACTOR.

ARTICLE 6. CONTRACT DOCUMENTS

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

- 6.1 Procurement Requirements (including Advertisement for Bids, Instructions to Bidders, Supplementary Instructions to Bidders, Proposal, Legal Status of Bidder, and other documents listed in the Table of Contents thereof).
- 6.2 This Agreement
- 6.3 Performance and other Bonds
- 6.4 Notice of Award
- 6.5 Notice to Proceed (if issued)
- 6.6 Conditions of the Contract (including General Conditions and Supplementary Conditions, if any)
- 6.7 Specifications contained within Division 01 through 49 of the Contract Documents dated May 2021
- 6.8 Plans consisting of sheets dated May 2021 and with each sheet bearing the following general title: WPC Third Avenue Pumping Station Improvements
- 6.9 Addenda numbers _____ to ____, inclusive
- 6.10 Documentation submitted by CONTRACTOR prior to Notice of Award
- 6.11 Any Modification, including Change Orders, duly delivered after execution of Agreement.

ARTICLE 7. MISCELLANEOUS

- 7.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions shall have the meanings indicated in the General Conditions.
- 7.2 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.
- 7.3 OWNER and CONTRACTOR each binds himself, his partners, successors, assigns and legal representatives to the other party hereto, his partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.
- 7.4 Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon OWNER and CONTRACTOR, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

IN WITNESS WHEREOF, the parties hereto have signed this Agreement in _____ counterparts. _____ counterparts each have been delivered to OWNER and CONTRACTOR; one counterpart 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 | CONTRACTOR |
| Ву | Ву |
| Attest | Attest |
| Address for giving notices | Address for giving notices |
| | |
| | |
| | |
| | License No. |
| | Agent for service of process: |
| | |

Section 00 5500 Notice to Proceed

| То: | | Date: | , 20 |
|--|--|---|--|
| | | | |
| Attention: | | | |
| Project: WPC Third Avenue Pumping Sta | ation Improveme | ents | |
| Please note that the Contract Time under 20 Within ten (10) days of this date y Completion and Final Completion are within () calendar days and Proceed, respectively. | the above Contr You are to start pe _, and res () ca | ract will commence to r erforming the Work. The pectively, given the Work lendar days after issuar | un on,, dates of Substantial k is to be completed nce of the Notice to |
| In accordance with paragraph 2.05 of the G schedules prior to the scheduling of a Pre-C | General Condition | ns, please submit to ENG ting. | INEER the required |
| Also, in accordance with paragraph 2.05 o Meeting from ENGINEER prior to delivery three (3) full working days notice is require ENGINEER three (3) full working days in a Project. | of the General Co of any materials ed to set up the F advance of any st | nditions, please request or start of any construc Pre-Construction Meeting aking requirements or o | a Pre-Construction ction. A minimum of g. Also, please notify other activity on the |
| Work at the site must be started by, _ | , 20 | | |
| Copy to ENGINEER: | | | |
| Wade Trim, Inc. 555 S. Saginaw Street, Suite 201 | | (OWNER) | |
| Flint, MI 48502 | By: | | |
| | | (Authorized Signat | cure) |
| | | | |
| | | | |
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Section 00 6000 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 in Exhibit 1 of the Contract Documents:
 - 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
 - 13. City of Flint Material Disposal Form

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

Section 00 6112 Performance Bond

| Bond No. | |
|----------|--|
|----------|--|

| KNOW ALL BY THESE PRESENTS, 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 St | tate 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 |
| (<u>\$</u>) lawful money of the United States of Americ | ca, to be paid to the said Obligee, to which |
| payment well and truly to be made, we bind ourselves, our heir | s, administrators, executors, successors and |
| assigns, jointly and severally, firmly by these presents. | |
| THE CONDITIONS OF THIS OBLIGATION is such that, WHERE | EAS, the above Principal has entered into a |
| contract with the said Obligee, dated the day of | , for |
| | |
| | |
| | |
| Herein referred to and made a part hereof as fully and to the written herein, and | e same extent as if the same were entirely |

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 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 _____.

Signed, sealed and delivered in the presence of:

| Witness for CONTRACTOR | (Principal) | |
|-------------------------|-------------------|----------|
| | (Title) | |
| | Ву | |
| Witness for Surety | (Surety) | |
| | (Title) | |
| Attorney-In-Fact (Seal) | By | |
| Address | Address of Surety | |
| City Zij | p Code City | Zip Code |
| Telephone | Telephone | |

Section 00 6113 Labor and Material Payment Bond

| | 201141101 |
|--|---|
| KNOW ALL MEN BY THESE PRESENTS, 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 St | tate 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 Ameri | ca, to be paid to the said Obligee, to which |
| payment well and truly to be made, we bind ourselves, our heir | s, administrators, executors, successors and |
| assigns, jointly and severally, firmly by these presents. | |
| | |
| THE CONDITIONS OF THIS OBLIGATION is such that, WHERE | EAS, the above Principal has entered into a |
| contract with the said Obligee, dated the day of | , for |
| | |

which contract is 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 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 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.

Bond No

| Signed and sealed this | s day of | |
|------------------------|----------|--|
|------------------------|----------|--|

Signed, sealed and delivered in the presence of:

| Witness for CONTRACTOR | | (Principal) | |
|-------------------------|----------|-------------------|----------|
| | | (Title) | |
| | | Ву | |
| Witness for Surety | | (Surety) | |
| | | (Title) | |
| Attorney-In-Fact (Seal) | | Ву | |
| Address | | Address of Surety | |
| City | Zip Code | City | Zip Code |
| Telephone | | Telephone | |

Section 00 6119 Maintenance & Guarantee Bond

| | | Bond No |
|--|-------------------------|------------------------------------|
| KNOW ALL BY THESE PRESENTS, that we, | | , a corporation organized |
| and existing under the laws of the State of | , and duly at | uthorized to transact business in |
| the State of Michigan, hereinafter called the "Principal, | ," and | , |
| a corporation organized and existing under the laws of | f the State of | , and duly |
| authorized to transact business in the State of Michigan | , as Surety, hereinafte | er called "Surety", are held and |
| firmly bound unto | , as Obligee, and her | reinafter called "Obligee," in the |
| just and full sum of | (\$ |) Dollars lawful money of |
| the United States of America, to be paid to the said Oblig | gee, to which payment | well and truly to be made, we |
| bind ourselves, our heirs, administrators, executors, su | ccessors 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 ______, ____, 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

NOW THEREFORE, the condition of this obligation is that under the Contract Documents, CONTRACTOR 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 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. 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.

Dand Ma

If CONTRACTOR or Surety shall fail to do as hereinbefore specified, they shall jointly and severally indemnity, defend, and hold harmless OWNER from and against all and any losses, costs, suits, and actions for damages of every kind and description brought or claimed against OWNER for or on account of any injury or damage to persons or property received or sustained by any party or parties by or from any of the acts of omissions or through the negligence of CONTRACTOR, its Subcontractors, Suppliers, servants, agents, or employees in connection with the Work and then from any and all claims arising under the Workmen's Compensation Act of the State of Michigan.

IN WITNESS WHEREOF, the parties hereto have caused this Maintenance and Guarantee Bond to be executed by their respective authorized officers this ______ day of _____, 20__.

| Witness for CONTRACTOR | | (Principal) | |
|-------------------------|----------|-------------------|----------|
| | | (Title) | |
| | | Ву | |
| Witness for Surety | | (Surety) | |
| | | (Title) | |
| Attorney-In-Fact (Seal) | | Ву | |
| Address | | Address of Surety | |
| City | Zip Code | City | Zip Code |
| Telephone | | Telephone | |

Signed, sealed and delivered in the presence of:

Section 00 6275 Engineer's Certificate for Payment

| Job Number: Certificate | • Number: Date: |
|---|--|
| OWNER: | |
| CONTRACTOR: | |
| Project: | |
| Contract Date: | |
| Substantial Completion Date: Extended | То: |
| Completion Date: Extended | То: |
| 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 | Total Balance Due this Certificate |
| ENGINEER'S CERTIFICATE FOR PAYMENT | |
| In accordance with the Contract Documents, based on the data comprise the above application, the ENGINEER to the best of his knowled information, and belief and subject to the limitations stated in the Cont Documents certifies to the OWNER that: (1) Work has progressed to point indicated, (2) that the quality of the Work is in accordance with Contract Documents, and (3) the CONTRACTOR is entitled to paymen the Total Balance Due This Certificate. | sing dge, ract the the t of |
| Certified ENGINEER Date | Recommended Dat |
| | |

Section 00 6276 Contractor's Application for Payment

| Job No | Application No. | Date |
|---|--|---|
| OWNER: | | |
| CONTRACTOR: | | |
| Project: | | |
| Period of this Application for Payment and Dec | claration | to |
| Contract Dated | | |
| CONTRACTOR'S CERTIFICAT | TION | CONTRACTOR'S DECLARATION |
| Total Earned to Date\$ | | I hereby declare that I have not, during the period covered by this |
| Less Total Earned to Date\$ Previous Certificate No | | 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 |
| Total Earned This Application\$ The undersigned CONTRACTOR certifies the knowledge, information, and belief the W Application for Payment has been completed in Contract Documents, that all amounts have been for which previous Certificates for Payment we received from the OWNER, and that current par now due. | at to the best of his ork covered by this n accordance with the n paid by him for Work re issued and payments yment shows herein is | 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. |
| (CONTRACTOR) | | (CONTRACTOR) |
| Ву: | | By: |
| Title: | | Title: |

Section 00 6277 Payment Schedule

| Job No | Application No | Date |
|----------|----------------|---------|
| Project: | | Period: |

| Item of Work | Unit | Original Est. Quantity | Unit Price | Period Quantity | Period Amount | Total Quantity to Date | Total Amount to Date |
|--------------|------|---------------------------|------------|-----------------|------------------|---------------------------|-------------------------|
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Section 00 6325 Substitution Request Form

| Spec | cification Section # | |
|-------|--|-----------------|
| Artio | cle # | |
| Spec | cified Product | |
| Prop | posed Substitution | |
| A. | Does specified product exceed, in any respect proposed substitution? | |
| B. | Does substitution affect dimensions shown on Plans? | |
| C. | Does substitution affect other trades more than original product? | $\Box Y \Box N$ |
| D | Does warranty differ from that specified? | $\Box Y \Box N$ |
| E. | Does substitution affect cost to OWNER? | $\Box Y \Box N$ |
| F. | Does substitution result in any license fee or royalty? | $\Box Y \Box N$ |

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: | Date Submitted: |
|---------------|-----------------|
| Company: | |
| Address: | |
| Telephone: | Fax: |
| Signature: | |

For use by ENGINEER

| ENGINEER'S RESPONSE | RESPONSE REQUIRED OF CONTRACTOR | | |
|---|---|--|--|
| No Exceptions TakenNote MarkingsComments AttachedRejected | NoneImage: ConfirmConfirmImage: ConfirmResubmitImage: Confirm | | |
| Rejected L resubline L 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 plans and specifications, 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. | | | |
| Ву | Date | | |

Section 00 6520 Sworn Statement

STATE OF MICHIGAN

| COUNTY OF} | |
|--|--|
| | being duly sworn, deposes and says: |
| is the (CONTI | RACTOR) (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 (CONTRACTOR) (Subcontractor) has (contracted) (subcontracted) for performance under the contract with 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, or 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 |
|--|-------------------------------------|----------------------------|---------------------------|------------------------------|--------------------------------------|---|---|
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| | TOTALS: | | | | | | |

(Some columns are not applicable to all persons listed)

(CONTINUED)

That the 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: AN OWNER OR LESSEE OF THE PROPERTY DESCRIBED ON THE REVERSE SIDE MAY NOT RELY ON THIS SWORN STATEMENT TO AVOID THE CLAIM OF A SUBCONTRACTOR, SUPPLIER, OR LABORER WHO HAS PROVIDED A NOTICE OF FURNISHING OR A LABORER WHO MAY PROVIDE 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.

(Deponent)

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.

| Subscribed and sworn to before me this | day of | 20 |
|--|--------|------|
| Subscribed and Sworn to before me this | uay 01 | , 20 |

Notary Public

_____ County, Michigan

My Commission Expires _____

INSTRUCTIONS

- 1. 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.
- 2. An OWNER or lessee may withhold payment to a CONTRACTOR or Subcontractor who has not provided a Sworn Statement. An 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.
- 3. An 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.
- 4. If the contract provides for payments by the OWNER to the general 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 general 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 general contractor.

Section 00 6521 Prevailing Federal Wage Rate – Davis Bacon Act

Part 1 General

1.01 Summary

- A. 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. A copy of the Federal Labor Standards Provisions is included and is hereby a part of this contract.
- B. 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.
- C. 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.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

End of Section

See Next Page for Wage Rate Determination.

Superseded General Decision Number: MI20200057

State: Michigan

Construction Type: Heavy

County: Genesee County in Michigan.

Heavy, Includes Water, Sewer Lines and Excavation (Excludes Hazardous Waste Removal; Coal, Oil, Gas, Duct and other similar Pipeline Construction)

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.95 for calendar year 2021 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.95 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2021. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

| Modification Number Ø | Publication Date 01/01/2021 | |
|--------------------------|--------------------------------|---------|
| CARP0706-017 06/01/20 | 020 | |
| | Rates | Fringes |
| CARPENTER, Includes Fo | orm Work\$ 28.21 | 21.54 |
| ELEC0948-009 06/01/20 | 020 | |
| | Rates | Fringes |
| ELECTRICIAN | \$ 39.17 | 23.51 |

* ENGI0325-019 09/01/2020

POWER EQUIPMENT OPERATORS: Underground Construction (Including Sewer)

| | Rates | Fringes |
|--------------------------|----------|---------|
| POWER EQUIPMENT OPERATOR | | |
| GROUP 1 | \$ 35.88 | 24.85 |
| GROUP 2 | \$ 31.15 | 24.85 |
| GROUP 3 | \$ 30.42 | 24.85 |
| GROUP 4 | \$ 29.85 | 24.85 |

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

GROUP 1: Backhoe/ Excavator, Boring Machine, Bulldozer, Crane, Grader/ Blade, Loader, Roller, Scraper, Trencher (over 8 ft. digging capacity)

GROUP 2: Trencher (8-ft digging capacity and smaller)

GROUP 3: Boom Truck (non-swinging, non- powered type boom)

GROUP 4: Broom/ Sweeper, Fork Truck, Tractor, Bobcat/ Skid Steer /Skid Loader

EXCLUDES UNDERGROUND CONSTRUCTION

| | | Nales | Fringes |
|-----------|-----------------|-------|---------|
| OPERATOR: | Power Equipment | | |
| Group | 1\$ | 40.38 | 24.85 |
| Group | 2\$ | 37.08 | 24.85 |
| Group | 3\$ | 34.43 | 24.85 |
| Group | 4\$ | 32.72 | 24.85 |
| Group | 5\$ | 32.72 | 24.85 |
| Group | 6\$ | 26.86 | 24.85 |
| | | | |

Datas

Eningos

FOOTNOTES:

Crane operator with main boom and jib 300' or longer: \$1.50 per hour above the group 1 rate. Crane operator with main boom and jib 400' or longer: \$3.00 per hour above the group 1 rate.

PAID HOLIDAYS: New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

GROUP 1: Crane operator with main boom and jib 400', 300', or 220' or longer.

GROUP 2: Crane operator with main boom and jib 140' or longer, tower crane, gantry crane, whirley derrick

GROUP 3: Backhoe/Excavator; Boring Machine; Bulldozer; Crane; Grader/Blade; Loader; Roller; Scraper; Tractor; Trencher

GROUP 4: Bobcat/Skid Loader; Broom/Sweeper; Fork Truck (over 20' lift)

GROUP 5: Boom truck (non-swinging)

GROUP 6: Fork Truck (20' lift and under for masonry work)

_____ IRON0025-006 06/01/2019

| | Rates | Fringes |
|-------------|----------|---------|
| IRONWORKER | | |
| Reinforcing | \$ 30.98 | 27.99 |
| Structural | \$ 36.77 | 29.03 |
| | | |

LAB00334-009 06/01/2019

EXCLUDES OPEN CUT CONSTRUCTION

| | I | Rates | Fringes |
|-------------|---------|-------|---------|
| Landscape I | Laborer | | |
| GROUP | 1\$ | 20.75 | 7.10 |
| GROUP | 2\$ | 18.75 | 7.10 |
| 31000 | | 10.75 | /.1 |

LANDSCAPE LABORER CLASSIFICATIONS

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

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

LAB00334-015 09/01/2018

SCOPE OF WORK: OPEN CUT CONSTRUCTION: Excavation of earth and sewer, utilities, and improvements, including underground piping/conduit (including inspection, cleaning, restoration, and relining)

| Rates | Fringes |
|-------------------------------|---------|
| LABORER | |
| (1) Common or General\$ 21.94 | 12.85 |
| (2) Mason Tender- | |
| Cement/Concrete\$ 22.08 | 12.85 |
| (4) Grade Checker\$ 22.25 | 12.85 |

| (5) Pipelayer | \$ 22.39 | 12.85 |
|---------------|----------|-------|
| (7) Landscape | \$ 16.84 | 12.85 |
| | | |

LAB01075-010 06/01/2019

EXCLUDES OPEN CUT CONSTRUCTION

| | Rates | Fringes |
|--|------------------------|------------------------|
| LABORER Common or General; Grade Checker; Mason Tender - Cement/Concrete; Pipelayer. | .\$ 23.00 | 13.66 |
| PAIN1052-003 05/01/2020 | | |
| | Rates | Fringes |
| PAINTER Brush & Roler Spray | .\$ 25.50 .\$ 26.85 | 14.15 14.15 |
| PLAS0016-016 04/01/2014 | | |
| | Rates | Fringes |
| CEMENT MASON/CONCRETE FINISHER | .\$ 25.58 | 12.88 |
| PLUM0370-006 06/01/2020 | | |
| | Rates | Fringes |
| PLUMBER/PIPEFITTER | .\$ 39.81 | 20.95 |
| TEAM0007-006 06/01/2020 | | |
| | Rates | Fringes |
| TRUCK DRIVER Dump Truck under 8 cu. yds.; Tractor Haul Truck Dump Truck, 8 cu. yds. and | .\$ 27.90 | .50 + a+b |
| over Lowboy/Semi-Trailer Truck | .\$ 28.00 | .50 + a+b .50 + a+b |
| FOOTNOTE: a. \$470.70 per week. b. \$68.70 daily. | | |
| 20012010-022 11/03/2010 | | |
| | Rates | Fringes |
| TRUCK DRIVER: Off the Road Truck | .\$ 20.82 | 3.69 |
| | | |

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

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

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

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

Union Rate Identifiers

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

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

Survey Rate Identifiers

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

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

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-0H-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

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

WAGE DETERMINATION APPEALS PROCESS

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

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

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

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

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

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

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

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

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

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

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

END OF GENERAL DECISION

...

Superseded General Decision Number: MI20200157

State: Michigan

Construction Type: Heavy PIPELINE

Counties: Michigan Statewide.

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.95 for calendar year 2021 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.95 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2021. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate, if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

| Modification | Number | Publication | Date |
|--------------|--------|-------------|------|
| 0 | | 01/01/2021 | |
| 1 | | 06/04/2021 | |
| 2 | | 06/18/2021 | |

ENGI0325-012 05/01/2021

| | Rates | Fringes |
|--|----------|---------|
| Power equipment operators - gas distribution and duct | | |
| installation work: | | |
| GROUP 1 | \$ 33.48 | 24.85 |
| GROUP 2 | \$ 31.45 | 24.85 |
| GROUP 3 | \$ 30.35 | 24.85 |

SCOPE OF WORK: The construction, installation, treating and reconditioning of pipelines transporting gas vapors within cities, towns, subdivisions, suburban areas, or within private property boundaries, up to and including private meter settings of private industrial, governmental or other premises, more commonly referred to as ""distribution work,"" starting from the first metering station, connection, similar or related facility, of the main or cross country pipeline and including duct installation.

Group 1: Backhoe, crane, grader, mechanic, dozer (D-6 equivalent or larger), side boom (D-4 equivalent or larger), trencher(except service), endloader (2 yd. capacity or greater).

GROUP 2: Dozer (less than D-6 equivalent), endloader (under 2 yd. capacity), side boom (under D-4 capacity), backfiller, pumps (1 or 2 of 6-inch discharge or greater), boom truck (with powered boom), tractor (wheel type other than backhoe or front endloader). Tamper (self-propelled), boom truck (with non-powered boom), concrete saw (20 hp or larger), pumps (2 to 4 under 6-inch discharge), compressor (2 or more or when one is used continuously into the second day) and trencher(service).

GROUP 3: Oiler, hydraulic pipe pushing machine, grease person and hydrostatic testing operator.

* LAB01076-005 04/01/2021

| | Rates | Fringes |
|-----------------------------|----------|---------|
| LABORER (DISTRIBUTION WORK) | | |
| Zone 1 | \$ 23.92 | 12.95 |
| Zone 2 | \$ 22.22 | 12.95 |
| Zone 3 | \$ 20.35 | 12.95 |
| Zone 4 | \$ 19.77 | 12.95 |
| Zone 5 | \$ 19.75 | 12.95 |

DISTRIBUTION WORK - The construction, installation, treating and reconditioning of distribution pipelines transporting coal, oil, gas or other similar materials, vapors or liquids, including pipelines within private property boundaries, up to and including the meter settings on residential, commercial, industrial, institutional, private and public structures. All work covering pumping stations and tank farms not covered by the Building Trades Agreement. Other distribution lines with the exception of sewer, water and cable television are included.

Underground Duct Layer Pay: $40\ {\rm per}$ hour above the base pay rate.

Zone 1 - Macomb, Oakland and Wayne

Zone 2 - Monroe and Washtenaw

Zone 3 - Bay, Genesee, Lapeer, Midland, Saginaw, Sanilac, Shiawassee and St. Clair Zone 4 - Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon and Schoolcraft Zone 5 - Remaining Counties in Michigan

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

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

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

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

WAGE DETERMINATION APPEALS PROCESS

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

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

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

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

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

Wage and Hour Administrator U.S. Department of Labor 200 Constitution Avenue, N.W. Washington, DC 20210 The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

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

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

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

END OF GENERAL DECISION"

Section 00 7300 Supplementary Conditions

These Supplementary Conditions amend or supplement Section 00 7200, General Conditions, as indicated below. All provisions which are not amended or supplemented by this section remain in full force and effect. The terms used in these Supplementary Conditions have the meanings assigned to them in the General Conditions.

SGC-5.03.D Additional Insured

Add the following language at the end of Article 5.03.D. of the General Conditions:

The name insured on OWNER's and CONTRACTOR's Protective Policy shall be: The City of Flint

Additional named insured on OWNER's and CONTRACTOR's Protective Policy shall include:

- 1. Wade Trim, Inc.
- 2. Hubbell, Roth & Clark, Inc.

SGC-5.04 Limits of Liability

The required limits of liability for insurance coverages requested in Section 5.03 shall be not less than the following:

| SGC-5.04.A Worker's Compensation | | |
|---|-------------|----------|
| Coverage A – Compensation | Sta | tutory |
| 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 | \$2, | 000,000 |
| Products – Com/Ops Aggregate | \$2, | 000,000 |
| Personal and Advertising Injury | \$1, | 000,000 |
| Each Occurrence | \$1, | 000,000 |
| Fire Damage (any one fire) | \$ | 50,000 |
| Medical Expense (any one person) | \$ | 5,000 |
| SGC-5.04.C Comprehensive Automobile Liability | | |
| Bodily Injury | \$1, | 000,000 |
| Property Damage | \$1, | 000,000 |
| or combined single limit | \$1, | 000,000 |
| SGC-5.04.D Owner's Protective – Coverage shall be Occ | urre | nce Form |
| General Aggregate | \$1, | 000,000 |
| Each Occurrence | \$1, | 000,000 |
| SGC-5.04 F Umbrella or Excess Liability | | |
| Each Occurrence | \$2 | 000 000 |
| Aggregate | \$2. | 000.000 |
| | ₩ ⊒, | , |

SGC-18 Dispute Resolution

Dispute resolution, if applicable, are referenced in the General Conditions. The requirements for dispute resolution should be included herein:

SUPPLEMENTARY CONDITIONS

Article 18 Dispute Resolution

18.01 Methods and Procedures

- A. Either OWNER or CONTRACTOR may request mediation of any Claim submitted to ENGINEER for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 11.01.
- B. OWNER and CONTRACTOR shall participate in the mediation process in good faith. The process shall be concluded within sixty (60) days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the Claim is not resolved by mediation, ENGINEER's action under Paragraph 11.01 or a denial pursuant to Paragraphs 11.01 shall become final and binding 30 days after termination of the mediation unless, within that time period, OWNER or CONTRACTOR:
 - 1. elects in writing to demand arbitration of the Claim, pursuant to Paragraph 18.02; or
 - 2. agrees with the other party to submit the Claim to another dispute resolution process.

18.02 Arbitration

- A. Claims or counterclaims, disputes, or other matters in question between OWNER and CONTRACTOR arising out of or relating to the Contract Documents or the breach thereof (except for Claims which have been waived by the making or acceptance of final payment as provided by Paragraph 14.01) including but not limited to those not resolved under the provisions of Paragraphs 18.01 will be decided by arbitration in accordance with the rules of the American Arbitration Association, subject to the conditions and limitations of this Paragraph. This agreement to arbitrate and any other agreement or consent to arbitrate entered into will be specifically enforceable under the prevailing law of any court having jurisdiction.
- B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitrator or arbitration provider, and a copy will be sent to ENGINEER for information. The demand for arbitration will be made within the 30-day period specified in Paragraph 18.01, and in all other cases within a reasonable time after the Claim or counterclaim, dispute, or other matter in question has arisen, and in no event shall any such demand be made after the date when institution of legal or equitable proceedings based on such Claim or other dispute or matter in question would be barred by the applicable statue of limitations.
- C. No arbitration arising out of or relating to the Contract Documents shall include by consolidation, joinder, or in any other manner any other individual or entity (including ENGINEER, and ENGINEER's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:
 - 1. the inclusion of such other individual or entity is necessary if complete relief is to be afforded among those who are already parties to the arbitration; and

- 2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration and which will arise in such proceedings.
- D. The award rendered by the arbitrator(s) shall be consistent with the agreement of the parties, in writing, and include:
 - 1. a concise breakdown of the award;
 - 2. a written explanation of the award specifically citing the Contract Document provisions deemed applicable and relied on in making the award.
- E. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Controlling Law relating to vacating or modifying an arbitral award.
- F. The fees and expenses of the arbitrators and any arbitration service shall be shared equally by OWNER and CONTRACTOR.

SGC-19 Liquidated Damages

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

Article 19 Liquidated Damages

- A. If CONTRACTOR shall fail to Substantially Complete the Work within the Contract Time, or extension of time granted by OWNER, then CONTRACTOR will pay to OWNER the amount for liquidated damages as specified in the Agreement for each calendar day that CONTRACTOR shall be in default after the time stipulated in the Contract Documents. The liquidated damages charged shall be deducted from 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 CONTRACTOR has given written notice of such delay within seven (7) calendar days to OWNER or ENGINEER.
 - 1. To any preference, priority or allocation order duly issued by the OWNER.
 - 2. 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
 - 3. To any delays of subcontractors occasioned by any of the causes specified in Items A and B of this Article.

End of Section

Division 01 General Requirements
Section 01 1100 Summary of Work

Part 1 General

1.01 Work Covered by Contract Documents

A. This Project includesimprovements to the Third Avenue Pumping Station including building improvements in the form of brick repair, roof replacement and new windows; removal and replacement of a 60-inch diameter isolation valve with a new 60-inch diameter knife gate and coupling, including an electric motor actuator; removal of an existing wet weather pump with an 18-mgd dry-pit submersible pump for dry weather, including piping, fittings, valves, variable frequency drive, instrumentation and controls. Work will also include replacing two existing valves at the WPCF with two new valves – a 72-inch and a 50-inch knife gate – including a new valve vault structure and appurtenances. Work at both the Third Avenue Pumping Station and the WPCF will require temporary line stops; bypass pumping up to 50 mgd will be required at the Third Avenue Pumping Station.

1.02 Work by Others

A. While there is no other work in the immediate Project area there will be several construction projects that will be underway during the same period as this Work. This CONTRACTOR shall therefore coordinate with OWNER and other contractors onsite to minimize disruption to this Work.

1.03 CONTRACTOR's Use of Premises

A. CONTRACTOR shall maintain his construction operations within the presently existing road rights-of-way and easements throughout the Project area. In the event that CONTRACTOR deems it necessary or advisable to operate beyond the limits of the existing rights-of-way or easements, he shall be responsible for making special written agreements with the property owners and shall furnish such copies of agreement to OWNER.

1.04 Photographs

A. Photographs, as specified in Section 01 3300, Submittal Procedures, shall be required for this Project.

1.05 Audio/Video Route Survey

A. An audio/video route survey, as specified in Section 01 3300, Submittal Procedures, shall be required for this Project. Complete coverage shall include the area inside and immediately adjacent to the building being renovated, including but not limited to:

1.

B. The audio/video route survey shall be delivered to ENGINEER on a USB drive. CONTRACTOR shall submit a minimum of two (2) copies of the survey.

1.06 Engineer's Field Office

A. A Field Office, as specified in Section 01 5000, Temporary Facilities and Controls, shall be required for this Project. Contractor shall coordinate placement of the Field Office with OWNER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 1213 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. Two existing pumps at the Third Avenue Pumping Station (TAPS) shall remain in service at all times except during the 60-inch valve replacement. During replacement of the 60-inch valve at TAPS, CONTRACTOR shall utilize the bypass pump system capable of pumping a minimum of 50 million gallons per day.
- B. New equipment specified in the Contract Documents shall be on site prior to starting respective shut down for replacement of old equipment.
- C. CONTRACTOR shall have blind flanges onsite and ready for installation for isolation purposes for respective pipe sizes.
- D. No open pipes in TAPS shall be allowed while work is not proceeding. CONTRACTOR shall blind flange open pipes during periods where construction activities have ceased.
- E. TAPS shall not be exposed to flooding at any time during the Work. Isolation measures to ensure this shall be considered as part of CONTRACTOR's work.
- F. Opening and closing of valves and stopping/starting of existing pumps at TAPS, as well as draining the existing discharge header and force main(s), shall be coordinated with WPCF staff. CONTRACTOR shall provide a minimum of 48 hours' notice to WPCF before requested opening/closing/ starting/stopping.

1.03 Work Sequence Description

- A. Preparation:
 - 1. Field measure and confirm existing pipe sizes, flange sizes, routing and layout.
 - 2. Submit shop drawings, including pipe and equipment layout drawings
 - 3. Excavate to the roof of the basement level of TAPS in the area of the discharge header.
 - a. Remove existing hatch and access structure.
 - b. Pour new filler slab for the existing hatch.
 - c. Install new support girder beams and allow sufficient time for concrete to cure to full strength prior to cutting openings in deck.
 - d. Install openings in top slab of basement over valves.
 - 4. Procure equipment.

- 5. Excavate 50-inch and 72-inch force mains at Water Pollution Control Facility (WPCF) in area of proposed Valve Vault to confirm alignment, outside pipe diameter, joint spacing, depth and width between the 50-inch and 72-inch pipes for new Valve Vault structure and line stop installation. Identify exact location for new structure based on CONTRACTOR layout. Report findings to ENGINEER.
- 6. Develop and submit detailed Work Plan for shutdown sequence, line stop installation, valve installation and Valve Vault installation. Plan shall include but not be limited to labor, material and equipment required for the work, as well as detailed sequencing of work with associated durations.
- B. Phase 1 60-inch TAPS Discharge Header Valve Replacement:
 - 1. General:
 - a. This phase is weather dependent. The 60-inch valve replacement at TAPS shall be completed only during dry weather flow and Work by CONTRACTOR shall continue 24 hours per day until complete. CONTRACTOR shall coordinate with OWNER on forecasted weather to identify start of this Work.
 - 2. Receive equipment necessary for 60-inch valve replacement.
 - 3. Run conduit and wiring to 60-inch valve actuator location.
 - 4. Install 72-inch line stop at TAPS.
 - 5. Install bypass pumping and test.
 - 6. Install temporary supports and rigging.
 - 7. Close suction side valves of existing pumps.
 - 8. Close cone valves.
 - 9. Close existing 48-inch header discharge valve to isolate from 50-inch force main to WPCF.
 - 10. Drain discharge header pipe and force main. CONTRACTOR shall pump or drain back into the wet well so as to not interfere with existing operations or equipment in Pump Room.
 - 11. Replace 60-inch valve in discharge header. The existing valve shall be removed, and the new valve installed within a 2-day duration.
 - 12. Connect electrical, instrumentation and controls to new 60-inch valve.
 - 13. Test and confirm no leaks at 60-inch valve.
 - 14. Startup and test 60-inch valve.
 - 15. Remove 72-inch line stop and return TAPS to normal operations.
- C. Phase 1A 42-inch TAPS Valve Replacements for Pumps #1 and Pump #2 (or see Phase 3A as option):
 - 1. Following installation of new 60-inch valve in TAPS discharge header, confirm pump suction side isolation valves remain closed; confirm cone valves remain closed.

- 2. Drain existing lines from Pump #1 and Pump #2, if required.
- 3. Remove existing bolted flexible connections and 42-inch discharge isolation valves from Pump #1 and Pump #2.
- 4. Install new 42-inch discharge isolation gate valves for Pump #1 and Pump #2. Reinstall bolted flexible connections with new gaskets, nuts and bolts and new pipe restraints.
- 5. Test and confirm no leaks in piping, fittings and valves for Pump #1 and Pump #2.
- 6. Start up and test 42-inch discharge isolation gate valves.
- D. Phase 1B TAPS Dry Weather Pump Installation:
 - 1. Receive 24-inch gate valve and new custom reducer fitting.
 - 2. During Phase 1 shutdown:
 - a. Isolate Pump #3 by closing existing isolation valves.
 - b. Remove existing 42-inch discharge isolation valve and piping to the existing cone valve.
 - c. Install 24-inch gate valve and custom reducer fitting.
 - d. Close 24-inch gate valve, install temporary support, and blind flange.
 - e. Remove existing Pump #3, including motor and associated piping and appurtenances.
 - f. Demolish concrete slab.
 - g. Excavate and extend concrete suction trench.
 - h. Install new dry weather pump supports and pump, valves and piping with supports.
 - i. Remove blind flange at new 24-inch gate valve and connect piping from new dry weather pump.
 - j. Install electrical, instrumentation and controls.
 - k. Startup, test and confirm no leaks in piping, fittings and valves for new dry weather pump.
- E. Phase 2 WPCF 50-inch Valve Installation:
 - 1. General:
 - a. CONTRACTOR shall provide temporary support of piping, including the 50inch and 72-inch force mains, as required to carry out the construction activities specified.
 - 2. Install 50-inch line stop.
 - 3. Isolate 50-inch force main coming from TAPS by closing the new 60-inch valve, and suction valves to Pump #4 and the new dry weather pump. Pump #1 and Pump #2 at TAPS shall remain in service (and discharging to the 72-inch force main).

- 4. Drain 50-inch force main.
- 5. Perform Work required to properly remove the designated section of the existing 50-inch force main.
- 6. Construct new Valve Vault (or portion thereof), valve, fittings, piping, couplings, restraints or transition pieces, as needed for the 50-inch force main.
- 7. Startup, test and confirm no leaks in piping, fittings and valve.
- 8. Remove 50-inch line stop and return 50-inch force main to normal operation.
- F. Phase 2A 42-inch TAPS Isolation Valve Installation (Pump #4 discharge):
 - 1. Isolate and drain existing line from Pump #4, if required.
 - 2. Remove existing bolted flexible connections and 42-inch discharge isolation valve from Pump #4.
 - 3. Install new 42-inch discharge isolation gate valve. Reinstall bolted flexible connections with new gaskets, nuts and bolts and new pipe restraints.
 - 4. Test and confirm no leaks in piping, fittings and valves.
 - 5. Start up and test 42-inch discharge isolation gate valve.
- G. Phase 3 WPCF 72-inch Valve Installation:
 - 1. Install 72-inch line stop.
 - 2. Isolate 72-inch force main coming from TAPS by closing the new 60-inch valve, and suction valves to Pump #1 and Pump #2. New dry weather pump and Pump #4 at TAPS shall remain in service (and discharging to the 50-inch force main).
 - 3. Drain 72-inch force main.
 - 4. Perform Work required to properly remove the designated section of the existing 72-inch force main.
 - 5. Construct new Valve Vault (or portion thereof, if not already constructed under Phase 2), valve, fittings, piping, couplings, restraints or transition pieces, as needed for the 72-inch force main.
 - 6. Startup, test and confirm no leaks in piping, fittings and valve.
 - 7. Remove 70-inch line stop and return 70-inch force main to normal operation.
- H. Phase 3A 42-inch TAPS Isolation Valve Installation (Pump #1 and Pump #2 discharge) *If not completed in Phase 1A.*
 - 1. Confirm pump suction side isolation valves are closed for Pump #1; repeat at Pump #2.
 - 2. Confirm cone valve is closed at Pump #1; repeat for Pump #2.
 - 3. Drain existing line, if required for Pump #1; repeat for Pump #2.
 - 4. Remove existing bolted flexible connections and 42-inch discharge isolation gate valve at Pump #1; repeat for Pump #2.

- 5. Install new 42-inch discharge isolation gate valve for Pump #1. Reinstall bolted flexible connections with new gaskets, nuts and bolts and new pipe restraints. Repeat for Pump #2.
- 6. Test and confirm no leaks in piping, fittings and valves for Pump #1 and Pump #2.
- 7. Start up and test 42-inch discharge isolation gate valves.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 2100 Allowances

Part 1 General

1.01 General

- A. CONTRACTOR shall include in his/her Bid the Allowance(s) listed in the Bid Proposal. These Allowances 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 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.

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 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.

1.04 Submittals

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

1.05 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 rurchase 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.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 2200 Unit Prices

Part 1 General

1.01 Scope

- A. This Section describes the method of measurement and basis of payment for all items of Work included in the Contract and specified in the Proposal. CONTRACTOR shall provide labor, material, tools, equipment and services required to complete the Work specified herein and indicated on the Plans.
- B. OWNER WILL MAKE NO ALLOWANCES FOR ITEMS NOT INCLUDED IN THE PROPOSAL.

1.02 Items of the Proposal

Item A1

Brick Repointing will be paid for at the Contract Unit Price, based on the actual lineal footage quantity of brick joint repointing on the Pump Station Building. Price paid shall be payment in full for all labor, material and equipment for performing this work, and all other items necessary to complete the job, whether specifically mentioned or not. Actual quantity to be agreed upon in the field during construction at a walk-through at the building with the CONTRACTOR, OWNER and ENGINEER. Quantities listed in the Proposal are to establish a base dollar amount in the Contract, which will be adjusted up or down based on actual quantities. The Work included and required by this item are described and shall be completed in accordance with Section 04 0511 Mortar and Grout, and 04 2200 Unit Masonry System, and the notes on sheets A-103, A-104, and A-105 of the Contract Drawings. This item includes the removal and installation of new mortar at deteriorated/cracked brick joints at denoted walls, as well as barricading, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied in the Contract Documents.

Item 2

Limestone Repointing will be paid for at the Contract Unit Price, based on the actual lineal footage quantity of limestone joint repointing on the Pump Station Building. Price paid shall be payment in full for all labor, material and equipment for performing this work, and all other items necessary to complete the job, whether specifically mentioned or not. Actual quantity to be agreed upon in the field during construction at a walk-through at the building with the CONTRACTOR, OWNER and ENGINEER. Quantities listed in the bid proposal are to establish a base dollar amount in the Contract, which will be adjusted up or down based on actual quantities. The Work included and required by this item are described and shall be completed in accordance with Section 04 0511 Mortar and Grout, and 04 2200 Unit Masonry System, and the notes on sheets A-103, A-104, and A-105 of the Contract Drawings. This item includes the removal and installation of new mortar at deteriorated/cracked limestone joints at denoted walls, as well as barricading, restoration, cleanup, and other related appurtenances necessary to complete the job, whether specifically mentioned or implied in the Contract Documents.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 2513 Substitution Procedures

Part 1 General

1.01 Section Includes

- A. Options for making product or process selections.
- B. Procedures for proposing equivalent construction products or processes, including preapproved, prequalified, and approved products or processes.

1.02 Definitions

- A. Product: Means materials, equipment, or systems incorporated into the Project. Product does not include machinery and equipment used for production, fabrication, conveying, and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. Process: Any proprietary system or method for installing system components resulting in an integral, functioning part of the Work. For this Section, the word Product includes Processes.

1.03 Selection Options

- A. Preapproved Products: Construction products of certain manufacturers or suppliers designated in the Specifications as "preapproved." A list of preapproved products is maintained by OWNER. Preapproved products for this Project are designated as preapproved in the Specifications. Products of other manufacturers or suppliers will not be acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- B. Prequalified Products: Construction products of certain manufacturers or suppliers designated in the Specifications as "prequalified." Prequalified products for this Project are designated as prequalified in the Specifications. Products of other manufacturers or suppliers will not be acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- C. Approved Products: Construction products or processes of certain manufacturers or suppliers designated in the Specifications followed by the words "or approved equal." Approval of alternate products or processes not listed in the Specifications may be obtained through provisions for product options and substitutions in Section 00 7200, General Conditions, and by following the submittal procedures specified in Section 01 3300, Submittal Procedures. The procedure for approval of alternate products is not applicable to preapproved or prequalified products.
- D. Product Compatibility: To the maximum extent possible, provide products that are of the same type or function from a single manufacturer, make, or source. Where more than one choice is available as a CONTRACTOR's option, select a product which is compatible with other products already selected, specified, or in use by OWNER.

1.04 CONTRACTOR's Responsibility

A. CONTRACTOR's responsibility related to product options and substitutions is defined in Section 00 7200, General Conditions.

- B. Complete the Substitution Request Form provided in Section 00 6325 and furnish information ENGINEER deems necessary to judge equivalency of the alternate product.
- C. Pay for laboratory testing, as well as any other review or examination costs, needed to establish the equivalency between products in order to obtain information upon which ENGINEER can base a decision.
- D. If ENGINEER determines that an alternate product is not equal to that named in the Specifications, CONTRACTOR shall furnish one of the specified products.

1.05 Engineer's Review

- A. Alternate products or processes may be used only if approved in writing by ENGINEER. ENGINEER's determination regarding acceptance of a proposed alternate product is final.
- B. Alternate products will be accepted if the product is judged by ENGINEER to be equivalent to the specified product or to offer substantial benefit to OWNER.
- C. OWNER retains the right to accept any product or process deemed advantageous to OWNER, and similarly, to reject any product or process deemed not beneficial to OWNER.

1.06 Substitution Procedure

- A. Collect and assemble technical information applicable to the proposed product to aid in determining equivalency as related to the approved product specified.
- B. Submit a written request for a construction product to be considered as an alternate product.
- C. Submit the product information after the effective date of the Agreement and within the time period allowed for substitution submittals given in Section 00 7200, General Conditions. After the submittal period has expired, requests for alternate products will be considered only when a specified product becomes unavailable because of conditions beyond CONTRACTOR's control.
- D. Submit six (6) copies of each request for alternate product approval. Include the following information:
 - 1. Complete data substantiating compliance of proposed substitution with Contract Documents.
 - 2. For products:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with product description, performance and test data, and reference standards.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which product was used and date of installation. Include the name of OWNER, ENGINEER, and CONTRACTOR.

- 3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
- 4. Itemized comparison of proposed substitution with product or method specified.
- 5. Data relating to changes in construction schedule.
- 6. Relation to separate contracts, if any.
- 7. Accurate cost data on proposed substitution in comparison with product or method specified.
- 8. Other information requested by ENGINEER.
- E. Approved alternate products will be subject to the same review process as the specified product would have been for shop drawings, product data, and samples.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 3119 Project Meetings

Part 1 General

1.01 **Preconstruction Meeting**

- A. Prior to the delivery of materials or the start of any construction, CONTRACTOR shall request a Preconstruction Meeting from 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 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. OWNER
 - 2. ENGINEER
 - 3. CONTRACTOR
 - 4. Subcontractor as appropriate to the agenda.
 - 5. Suppliers as appropriate to the agenda.
 - 6. 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 OWNER within seven (7) days of meeting for review at the next meeting.

1.03 Preinstallation Meeting

- A. When required in individual specification sections, CONTRACTOR convene a preinstallation meeting at the Site prior to commencing work of the section.
 - 1. Notify OWNER and ENGINEER four (4) days in advance of meeting date.
- B. CONTRACTOR shall require the attendance of parties directly affecting, or affected by, Work of the specific section.
- C. Prepare agenda and preside at meeting:
 - 1. Review conditions of installation, preparation and installation procedures.
 - 2. Review coordination with related work.
- D. CONTRACTOR shall record and distribute copies of meeting minutes within two (2) days after meeting to participants, with copies to ENGINEER, OWNER, participants, and those affected by decisions made.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 3300 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 ENGINEER for review in accordance with the provisions of General Conditions.

1.02 Schedule for Submission

- A. Prior to submitting any shop drawings, product data, portfolios, samples, etc. CONTRACTOR shall prepare a summary listing all items in the project which will be submitted for review by ENGINEER.
- B. The summary shall be submitted within twenty (20) calendar days after receipt of Notice to Proceed and shall be updated once per month thereafter.
- C. The summary shall include the proposed dates for submittal for each item for control purposes. The summary shall be prepared in coordination with the Project Schedule, allowing adequate time for review by ENGINEER and possible resubmittal by CONTRACTOR.
- D. The summary and schedule for submittals shall not relieve CONTRACTOR of his obligation to comply with specification requirements for items not listed on the Project Schedule.
- E. Nothing herein shall be construed as allowing additional time for completion of the project in the event resubmittal is required for shop drawings or the other items to be submitted.

1.03 Submission Requirements

- A. CONTRACTOR shall submit an entire package of Shop Drawings and product data information for major items of Work so that ENGINEER can review the package as a unit. CONTRACTOR shall transmit each submittal with an ENGINEER-approved transmittal form.
- B. Schedule submittals to expedite the Project and deliver to ENGINEER in a manner to allow sufficient time for review and processing by ENGINEER so as to not cause delays in the Work. CONTRACTOR shall coordinate submission of related items.
- C. Drawings, information and documentation shall be prepared and submitted with all words in the English language and dimensions in American units; no foreign language or metric units will be permitted.
- D. Identify variations from Contract Documents and Products and system limitations which may be detrimental to successful performance of the completed Work.
- E. Distribute copies of reviewed submittals to all concerned and related parties. Instruct parties to promptly report any inability to comply with provisions.
- F. ENGINEER reserves the right to refuse to check or review any submittal of a Subcontractor, Supplier or manufacturer which is not presented in compliance with the foregoing requirements.

- G. Each submittal shall:
 - 1. Be sequentially number the transmittal form. Re-submittals shall have original number and a sequential alphabetic suffix.
 - 2. Identify Project, CONTRACTOR, Subcontractor and supplier; pertinent drawing and detail number, and specification section number, as appropriate.
 - 3. Have CONTRACTOR's stamp that has been initialed or signed, certifying CONTRACTOR's review and approval of submittal per the General Conditions, 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.
- H. Electronic Submittals:
 - 1. Electronic submittals shall follow the procedures outlined above.
 - 2. Electronic submittal procedures are only applicable to Shop Drawings and product data submittals.
 - 3. Electronic submittals shall be made in a standard format ENGINEER has agreed in advance to accept, JPEG, TIF, DGN, DXF, DWG, or PDF.
 - 4. Reviewed submittals shall be returned in JPEG, TIF, or PDF electronic format for CONTRACTOR's printing and distribution.

1.04 Submittal Review

- A. Subcontractors, Suppliers and manufacturers' submittals shall first be sent directly to CONTRACTOR, who shall keep a record of the submittal numbers and the dates of receipt. CONTRACTOR shall check thoroughly the submittal in regard to measurements, sizes of members, materials, and other details to assure CONTRACTOR that they conform to the intent of the drawings and the specification, and shall promptly return to the Subcontractors, Suppliers and/or manufacturers for correction such submittals as are found inaccurate or otherwise in error.
- B. ENGINEER will review the submittal within 15 calendar days after receipt thereof and will return one (1) copy (unless otherwise specified), endeavoring to indicate, by notation thereon or written instructions, any correction which may be necessary to meet the Contract requirements.
 - 1. CONTRACTOR shall then review such notations and/or instructions and if CONTRACTOR concurs therein, shall make or have made such required corrections, and shall, when so noted on submittals or requested by ENGINEER, resubmit corrected submittals to ENGINEER as soon as possible, for final review.
 - 2. Such further review by ENGINEER will be limited to the corrections only, and CONTRACTOR, by such re-submission shall be held to have represented that such submittals contain no other alterations, additions or deletions, unless CONTRACTOR (in writing) directs ENGINEER 's specific attention to same.
 - 3. Should CONTRACTOR question, or dissent from, such notations and/or instructions, CONTRACTOR shall so inform ENGINEER and request further clarification before resubmitting submittals.

C. Review of submittals by ENGINEER is for coordination and assistance, and ENGINEER does not thereby assume responsibility for errors or omissions. Such errors or omissions must be made good by CONTRACTOR, irrespective of the receipt, review of the submittals by ENGINEER, and even though the Work is done in accordance with such submittals.

1.05 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 ENGINEER.

1.06 Progress Schedules

- A. CONTRACTOR shall submit a copy of each Progress Schedule indicating the starting and completion dates of the various stages of the Work and estimated payments during the next 3 months to ENGINEER.
 - 1. Proposed Progress Schedules shall be submitted to ENGINEER prior to the preconstruction meeting.
 - 2. CONTRACTOR shall distribute copies of the Progress Schedules during the preconstruction meeting for discussion.
 - 3. Progress Schedules shall be updated by CONTRACTOR and submitted to 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.

1.07 Shop Drawing Schedule

- A. CONTRACTOR shall submit a copy of each Shop Drawing Schedules indicating the individual items and submission dates to ENGINEER.
 - 1. A preliminary Schedule in accordance with the requirements in the General Conditions shall be submitted by CONTRACTOR prior to the preconstruction meeting.
 - 2. Copies of this preliminary Schedule shall be made available by CONTRACTOR during the preconstruction meeting.
 - 3. A final Schedule shall be submitted by CONTRACTOR at least ten (10) days prior to submitting the first Application for a Payment.

1.08 Schedule of Values

- A. CONTRACTOR, if applicable, shall a copy of the Schedule of Value of the Work to ENGINEER.
 - 1. A preliminary Schedule of Values shall be submitted by CONTRACTOR prior to the preconstruction meeting.
 - 2. A final Schedule of Values, prepared in accordance with the General Conditions and presented in sufficient detail to serve as the basis for payments during construction, shall be submitted to ENGINEER for approval at least ten (10) days prior to submitting the first Application for Payment.

1.09 Staking Schedule

- A. CONTRACTOR shall submit a copy of the Staking Schedule, in accordance with the "Construction Layout" specification section prior to the Start of Construction.
 - 1. The Staking Schedule should be updated as outlined in the specifications and submitted by CONTRACTOR to ENGINEER through completion of the Work.

1.10 Applications for Payment

- A. CONTRACTOR shall submit Applications for Payment to ENGINEER in accordance with the provisions of Article 14 of the General Conditions.
- B. Applications for Payment shall be made on forms provided by or approved by ENGINEER.
 - 1. Sample CONTRACTOR's Application/Declaration, Payment Schedule and ENGINEER's Certificate forms for this purpose are included in the Contract Documents.
- C. Copies of these forms, with Project specific information completed by ENGINEER, will be given to 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 ENGINEER not more often than once per month.
- E. ENGINEER will certify payments with the use of Engineer's Certificate for Payment.

1.11 Shop Drawings

A. Shop Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to Plan Sheet Number and Detail, and Specification Section Number and Page Number.

1.12 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.

1.13 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.

1.14 Specification Section Requirements

A. Miscellaneous schedules, field reports, test reports, affidavits, certificates, permits, agreements and other items identified in the Specification Sections, or as requested by ENGINEER shall be submitted to ENGINEER.

B. As a minimum, these submittals should be identified with the Project title, date of submission, and Specification section reference.

1.15 Manufacturer Installation Instructions

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation and start-up to ENGINEER in quantities specified for Product Data.
- B. Identify conflicts between manufacturer's instructions and Contract Documents.

1.16 Manufacturer Certificates

- A. When specified in individual sections, submit certification by manufacturer to ENGINEER in quantities specified for Product Data.
- B. Indicate material or Product meets or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product but must be acceptable to ENGINEER.

1.17 Manufacturer's Operation and Maintenance Data

- A. CONTRACTOR shall furnish four (4) copies 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 ENGINEER for review.
- B. 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.

1.18 Photographs

- A. When required in the Summary of Work, Section 01 1100, CONTRACTOR shall furnish ENGINEER a minimum of four (4) color digital photographs each month during construction of the Project. All photographs shall be taken at such times and of such views as ENGINEER directs.
- B. The following information shall be placed on the back of the photos: job name, contract number, description of view and date of photograph. CONTRACTOR shall submit photographs monthly along with the Application for progress Payment as described in Article 14 of the General Conditions.

1.19 Audio/Video Route Survey

- A. When required in the Summary of Work, Section 01 1100, or the Proposal, CONTRACTOR shall furnish 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, 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 preconstruction meeting.
- C. Format:
 - 1. Audio/Video route survey shall be submitted in the format(s) as specified in Section 01 1100, Summary of Work.
 - a. Audio/video route survey submission shall be on media meeting the following specifications:
 - (1) Media: USB
 - (2) Format: Video
 - (3) Video Encoding: Highest available bit rate (6-9 Megabit), 60 fields per second interlaced video
 - (4) Audio Encoding: Uncompressed stereo wave or stereo Dolby Digital (256 kilobit or better)
 - (5) Aspect Ratio: 4x3 (720x480 pixels)
 - (6) No Macrovision or other copy protection encoding. No region code or region code 1.
- D. When conventional wheeled vehicles are used, distance from the camera lens to the ground shall be not less than 12 feet (3.5 m) to ensure proper perspective. 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.

- E. Video recordings must, by electronic means, display continuously and simultaneously generated transparent digital information to include the date and time of recording, as well as the corresponding engineering stationing numbers as shown on the Plans.
 - 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.
- F. This transparent information will appear on the extreme upper left hand third of the screen. The 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. This transparent information must appear in the lower half of the viewing screen.
- G. 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 OWNER.
- H. In some instances, audio/video coverage may not be suitable for recording necessary details. In such instances, OWNER may specify still photographs to provide coverage. High-resolution photographs may be submitted digitally, in color, and must include a time and date stamp on the photograph and be accompanied by a suitable description of location of photograph either on the photo or in a caption.
- I. Any portion of the Audio/Video Route Survey of insufficient quality as determined by ENGINEER shall be redone by CONTRACTOR at no additional cost to OWNER.
- J. DVD disks or USBs be properly identified as to Project, location, time, and date in a manner acceptable to OWNER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 4500 Quality Control

Part 1 General

1.01 General Requirements

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

1.02 Control of Installation

- A. Monitor quality control over Suppliers, manufacturers, products, materials, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Work shall be performed by persons qualified to produce workmanship of specified quality.
- F. Secure products and materials in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.03 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. CONTRACTOR will appoint, employ, and pay for specified services of an independent firm to perform inspecting and testing, as required for concrete testing, soils compaction density and gradation testing, and asphalt density testing.
 - 1. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by ENGINEER or OWNER.
 - 2. Inspecting, testing, and source quality control may occur on or off the project site. Perform off site inspecting or testing as required by ENGINEER or OWNER.
- C. Reports will be submitted by the independent firm to ENGINEER, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- D. ENGINEER shall have access to 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 OWNER. In any case materials may be either inspected or tested when received on the Project.

- E. Materials shall not be used until approval has been received from ENGINEER. Approval of materials at the producing plant does not constitute a waiver of ENGINEER's right for re-examination at the Project site.
- F. 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.
- G. Sampling and testing of materials not specifically mentioned shall be done by generally accepted methods, unless otherwise specified by ENGINEER.
- H. Notify ENGINEER and independent firm 48 hours prior to expected time for operations requiring services.
- I. Testing or inspecting does not relieve CONTRACTOR of performing Work to Contract requirements.
- J. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by ENGINEER. Payment for retesting will be charged to CONTRACTOR by deducting inspecting or testing charges from the Contract Price.

1.04 Certification of Materials

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

1.05 Source Quality Control

A. Testing identified in the Specifications as Source Quality Control, which is required to establish quality of materials, equipment or fabricated items, shall be paid for by CONTRACTOR.

1.06 Inspector Days

- A. Resident Project Representative(s) will be assigned to the Project by ENGINEER, as necessary (in the opinion of ENGINEER) to adequately monitor CONTRACTOR's work.
 - 1. When multiple CONTRACTOR crews are working on the Project, multiple Resident Project Representatives may be assigned to the Project.
- B. If the quantity of Work under the Contract is changed, the number of "Inspector Days" shall be increased or decreased as determined by Article 10 or 11 of the General Conditions. This revision in the number of Inspector Days shall be agreed upon at the time the Contract quantities are revised.
- C. CONTRACTOR shall give ENGINEER at least 48 hours notice, exclusive of Saturdays, Sundays or holidays, when the Project requires an increase or decrease in the number of Resident Project Representatives.
 - 1. Failure to observe this requirement will either necessitate the charging of 4 hours show-up time if the Resident Project Representative appears on the Project, or the halting of all additional operations until a Resident Project Representative is available.

- D. Unless the Resident Project Representative is notified in advance, Inspector days will be charged when a Resident Project Representative appears on a project and CONTRACTOR decides not to work.
- E. A separate Inspector Day or a partial Inspector Day shall be charged for each and every Resident Project Representative working on a project for monitoring purposes.

1.07 Mockups

- A. Tests will be performed under provisions identified in this Section and identified in the respective specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mockups are representative of the quality required for the Work.
- D. Where mockups have been accepted by ENGINEER and is specified in specification section(s) to be removed, CONTRACTOR shall remove mockup and clear area when directed to do so.

1.08 Manufacturers' Field Services and Reports

- A. When specified in individual specification sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, test, adjust and balance of equipment and as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- C. Submit report in duplicate within 30 days of observation to Engineer for information.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 5000 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 ENGINEER.
- B. CONTRACTOR shall maintain driveways a minimum of 15 feet (5 m) 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 provide and maintain 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. Any areas damaged by emergency vehicles shall be restored by CONTRACTOR at no additional cost to OWNER.

1.03 Private or Public Roads, Sidewalks, and Parking Areas

- A. Where public roads, driveways, parking areas and sidewalks are encountered throughout the community, CONTRACTOR shall maintain those portions affected by the construction operations in a passable condition until such time as final restoration of these improvements can be made as specified.
 - 1. If, in the opinion of ENGINEER, the public safety is in danger or the necessity exists for maintaining traffic, ENGINEER may direct that backfilling be completed immediately.
 - 2. In the event that the necessary backfill material and equipment are not available when direction is given for immediate backfill, the trench shall be backfilled with native material to provide for the necessary maintenance of traffic and safety; however, the native material shall be removed within 48 hours and the trench properly backfilled as specified.
- B. Where private roads are encountered throughout the community, CONTRACTOR shall maintain those portions affected by its construction operations in a passable condition. These roads shall be maintained by the use of 21A road maintenance gravel, stone or slag.
 - 1. In the event the original subbase has been destroyed, CONTRACTOR shall furnish and install 1-inch to 2-inch (25 to 50 mm) aggregate to stabilize the existing subbase.

2. Upon completion of the construction activities, CONTRACTOR shall shape and regrade these roads leaving them in a condition as good as or better then original, and adequate for normal travel.

1.04 Road Closing

- A. No street, road or section thereof, whether public or private, shall be closed to through traffic unless otherwise provided for on the Plans, Specifications, or authorized by the agency with jurisdiction over the roads. Prior to closing a street, road, or section thereof, CONTRACTOR shall provide ENGINEER with a copy of a detour plan approved by the agency having jurisdiction over the roads.
- B. In the event roads or streets are to be closed, CONTRACTOR shall notify the local fire department, police department, local road authority, ambulance and emergency services, Department of Public Works, public transit authority and public school system daily as to what streets will be partly blocked or closed, the length of time the streets will be blocked or closed and when the streets will be reopened to traffic. CONTRACTOR shall designate one responsible employee to carry out the requirements of this condition.
- C. During the time that the road is closed, CONTRACTOR shall make provision for trash, leaf, and rubbish pickup.

1.05 Maintaining Traffic

- A. CONTRACTOR shall provide access for traffic by means of temporary roads, drives, culverts or other means approved by ENGINEER. CONTRACTOR shall grade, add surfacing materials, and dust palliatives to such temporary roads and drives as necessary for the proper maintenance of traffic.
- B. Where the shoulder is used to maintain traffic, the shoulder shall be graded, surfaced, treated for dust, constructed, or reconstructed, as specified herein or as shown on the Plans.
 - 1. If the construction work is suspended due to weather conditions, winter shut down or for any other reason, sufficient labor, materials and equipment shall be ready for immediate use at all times for the proper maintenance of traffic.
 - 2. Surfacing materials and dust palliatives shall be applied at such times and locations and in such amounts as necessary to safely maintain traffic and as determined by ENGINEER.
- C. Where shoulders are low, high, soft or rough, adequate provisions shall be taken to inform and protect the traveling public by means such as construction warning signs, barricades, lighted devices, etc. Such shoulder hazards shall be eliminated as soon as practicable.
- D. CONTRACTOR shall furnish, erect and maintain all signs, barricades, lights, and traffic regulators, in accordance with the requirements of the current "Michigan Manual of Uniform Traffic Control Devices." Furnish flagmen and watchmen as are necessary to maintain and safeguard traffic along the entire Project.
 - 1. Failure to comply with these requirements may be cause for the OWNER to issue a stop Work Order, which shall remain in effect until all necessary devices are in place and operational.
 - 2. The issuance of a stop Work Order shall not be reason for granting additional compensation or an extension to the Contract Time.

3. Furnishing, installing, and maintaining traffic control devices shall be incidental to the Project unless otherwise provided for in the Proposal.

1.06 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.

1.07 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 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 ENGINEER's field office. Toll charges for calls relating to Project business shall be at CONTRACTOR'S expense.

1.08 Use of Water

 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 water consumed during course of the Project at the current rate as set by the agency having jurisdiction.

1.09 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 OWNER and ENGINEER. All rules and regulations of the State and local health officials shall be observed, with precautions taken to avoid creating unsanitary conditions.

1.10 Potable Water

A. CONTRACTOR shall furnish a supply of potable water per MIOSHA requirements, available for use of construction personnel including OWNER and ENGINEER.

1.11 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 OWNER and ENGINEER. CONTRACTOR shall also furnish a communication system for contacting emergency services. Telephone numbers of the physician, hospital, or emergency services shall be conspicuously posted at the job site.

1.12 Engineer's Field Office

- A. When called for in the Summary of Work, Section 01 1100, CONTRACTOR shall furnish and maintain, for the exclusive use of ENGINEER, an approved weatherproof building as a field office. The building shall be located as directed by ENGINEER, in full view of the Work and with at least one (1) window facing construction operations. ENGINEER's field office shall meet the following minimum requirements:
 - 1. Securely fixed to foundation
 - 2. Structurally sound and watertight
 - 3. Stairs and landings for doors as necessary
 - 4. Three hundred (300) square feet (28 m²), minimum
 - 5. Three operable and locking windows with screens
 - 6. Two locking, standard sized, entrance/exit doors
 - 7. 120-volt electrical service per NEC, complete
 - 8. One 30" x 60" (.75m x 1.5m) desk
 - 9. One four drawer locking file cabinet
 - 10. Two desk chairs
 - 11. One first aid kit
 - 12. One 10A:80-B:C fire extinguisher
 - 13. Automatically controlled heating, ventilating, air conditioning system to maintain temperature between 68° and 76° Fahrenheit (20° and 25° Celsius) year-round.
- B. CONTRACTOR shall furnish and maintain bottled water and sanitary facilities for the field office. CONTRACTOR shall clean the office at least once per week. CONTRACTOR shall provide and pay for utility service throughout the duration of the Project, including telephone service and long-distance telephone service.
- C. A trailer having equal facilities and floor space may be used in place of the above described field office if so desired.
- D. The field office shall be furnished with a minimum of an aggregate surfaced driveway and parking area, for the exclusive use of ENGINEER, for at least three (3) vehicles.
 - 1. CONTRACTOR shall maintain parking area including snow removal.
- E. Cost for furnishing and installing the field office, for furnishing utilities and utility service, and for maintenance of the field office and facilities, unless otherwise specified in the Proposal, will not be paid for separately but shall be included in the price bid for various items of Work under the Contract.
 - 1. The building shall be removed by the CONTRACTOR upon completion of the Contract and shall become his property.

1.13 Bypass Pumping

A. Refer to Section 01 8933, Bypass Pumping.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)
Section 01 5713 Temporary Erosion and Sediment Control

Part 1 General

1.01 Scope of Work

A. This Section includes furnishing, installing, maintaining, and removing at project completion, Soil Erosion and Sedimentation Control devices. Devices include silt fence, straw bales, turbidity barriers, temporary gravel construction entrance/exits, inlet filters, ditch sediment traps, etc.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2200: Grading
- D. Section 31 2313: Subgrade Preparation
- E. Section 31 2319: Dewatering
- F. Section 31 2333: Trenching and Backfilling
- G. Section 31 3500: Slope Protection
- H. Section 32 9219: Seeding
- I. Section 32 9223: Sodding
- J. Section 33 1100: Water Utility Distribution Piping
- K. Section 33 3000: Sanitary Utility Sewerage Piping
- L. Section 33 3400: Sanitary Utility Force Mains
- M. Section 33 4100: Storm Utility Drainage Piping

1.03 Reference Standards

A. ASTM, American Society for Testing and Materials

1.04 Requirements of Regulatory Agencies

- A. CONTRACTOR, at his 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 and the National Pollution Discharge Elimination System (NPDES) Rules for storm water discharges from construction activity.
- B. Comply with requirements of the agency having jurisdiction. OWNER may withhold payment to CONTRACTOR equivalent to any fines resulting from non-compliance with applicable regulations.

1.05 Performance Requirements

- A. Employ Best Management Practices as defined by standard EPA 832-R-92-005.
- B. Put preventative measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- C. Control increased storm water runoff due to disturbance of surface cover due to construction activities for this Project.

- D. Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this Project.
- E. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall event that might occur in 10 years.
- F. Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this Project. Prevent windblown soil from leaving the project site. Comply with fugitive dust ordinances of agencies having jurisdiction. Prevent tracking or flowing of mud and sediment onto public or private roads, sidewalks or pavements outside of the site.
- G. Prevent sedimentation of waterways on or off the project site, including rivers, streams, lakes, ponds, open drainage ditches, storm sewers, and sanitary sewers. If sedimentation occurs, install or correct preventative measures immediately at no cost to OWNER. Comply with requirements of agencies having jurisdiction.
- H. Maintain temporary preventative measures until permanent measures have been established. Remove temporary measures when permanent measures have been established.
- I. If erosion or sedimentation occurs due to non-compliance with these requirements, remove deposited sediment or restore eroded areas at no cost to OWNER.

1.06 Submittals

- A. Submit schedule of Soil Erosion and Sedimentation Control activities to agency having jurisdiction. Include events (with days and/or dates of the various activities) for review and approval prior to obtaining a permit.
- B. CONTRACTOR must provide evidence of Storm Water Operator license.

Part 2 Products

2.01 Silt Fence

- A. Polypropylene geotextile fabric, resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; meeting the following requirements:
 - 1. Average Opening Size: 30 U.S. Std. Sieve 600 μm), maximum; ASTM D4751.
 - 2. Permittivity: 0.05 sec⁻¹, minimum; ASTM D4491.
 - 3. Ultraviolet Resistance: Retaining at least 70% of tensile strength; ASTM D4355 after 500 hours exposure.
 - 4. Tensile Strength: 100 lb-f (445 N) minimum, in cross-machine direction; 124 lb-f (551 N) minimum in machine direction; ASTM D4632.
 - 5. Elongation: 15 to 30%; ASTM D4632.

- 6. Tear Strength: 55 lb-f (244 N) minimum; ASTM D4533.
- B. Posts shall be 2 by 2-inch (50 mm x 50 mm) cross section hardwood stakes, minimum 3-feet (1.0 m) long.

2.02 Turbidity Barrier

- A. Geotextile fabric curtain suspended from flotation devices at the water surface and held in a vertical position by a ballast chain in the lower hem. Turbidity barrier curtain shall meet the following minimum requirements unless otherwise specified on the plans.
 - 1. Consist of vinyl laminate on 1000 denier polyester fabric weighing 18 ounce per square yard (610 g/m²) minimum.
 - 2. Tensile strength of fabric shall be 220 lbs (100 kg) minimum.
 - 3. Edges of fabric to be reinforced with minimum 5/8-inch (16 mm) diameter polypropylene rope.
 - 4. Ballast chain minimum 5/16-inch (8 mm) galvanized steel.
 - 5. Buoyancy blocks providing buoyancy of 18lbs/l.f (27 kg/m).
 - 6. Length of curtain (water depth) 5-feet (1.5 m).

2.03 Dewatering Discharge Filter Bag

- A. UV-stabilized, non-woven geotextile bag to filter sediment from water prior to discharging. Geotextile fabric shall meet the following minimum average roll requirements:
 - 1. Tensile Strength: 180 lb-f (200 N) minimum; ASTM D4632
 - 2. Elongation: 50 percent minimum; ASTM D4632
 - 3. CBR Puncture Strength: 300 lb-f minimum; ASTM D6241
 - 4. Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533
 - 5. Flow Rate: 80 gal/min/sf. (54 l/s/m²) Minimum; ASTM D4491
 - 6. Permittivity: 1.4 sec ⁻¹ minimum; ASTM D4491
 - 7. Apparent Opening Size: 80 U.S. Std. Sieve maximum; ASTM D4751
 - 8. UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

2.04 Erosion Control Blankets

- A. Machine produced blanket with a consistent thickness of evenly distributed straw or coconut fiber as specified. Unless otherwise specified on the Plans, the erosion control blanket shall have the following minimum properties:
 - 1. Double net 100% straw blanket.
 - 2. Top and bottom photodegradable polypropylene netting, 1.64 lbs./1,000 sft. (0.8 kg/ m²) approximate weight.
 - 3. 100% agricultural straw 0.5 lbs/sy (.27 kg/m²).
 - 4. Stitch spacing: 1.5 inches (40 mm) on centers.

B. Pegs shall be 6-inch (150 mm) long, hardwood pegs.

2.05 Bonded Fiber Matrix

- A. Bonded fiber matrix (BFM) shall consist of long strand, residual, softwood fibers joined together by a high-strength, non-toxic adhesive. BFM shall be 100% biodegradable, and be non-toxic to fish, wildlife, and humans. Upon drying the matrix shall form a high strength, porous and erosion resistant mat that shall not inhibit the germination and growth of plants. BFM shall retain its form despite re-wetting.
- B. Bonded fiber matrix shall consist of:
 - 1. Seed and Fertilizer per Section 32 9219, Seeding.
 - 2. Wood Fiber Mulch: Thermo-mechanically defibrated long, softwood fibers manufactured from select northern softwood wood chips.
 - 3. Polyacrylamide Binder: Site specific, fully biodegradable, polyacrylamides (PAM's) binders, with cross-linking long organic jute fibers
- C. Materials shall be mixed at the rate of 80 lbs/acre (90 kg/Ha) of PAM binder and 2500 lbs/acre (2800 kg/Ha) of wood fiber mulch.

2.06 Inlet Filter Fabric

- A. Filter fabric shall be constructed of 100% continuous polyester needle-punched nonwoven engineering fabric. Filter fabric shall be fabricated to provide a direct fit with the drainage structure cover. Filter fabric shall have the following minimum physical properties.
 - 1. Tensile Strength: 80 lb-f (.355 kN) minimum; ASTM D4632
 - 2. Elongation: 50 percent minimum; ASTM D4632
 - 3. CBR Puncture Strength: 300 lb-f, minimum; ASTM D6241
 - 4. Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533
 - 5. Flow Rate: 80 gal/min/sf. (54 l/s/m²) Minimum; ASTM D4491
 - 6. Permittivity: 1.4 sec ⁻¹ minimum; ASTM D4491
 - 7. Apparent Opening Size: 100 U.S. Std. Sieve (150 μm) maximum; ASTM D4751
 - 8. UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

2.07 Acceptable Manufacturers

- A. Acceptable manufacturers include the following:
 - 1. Turbidity Barrier: Tough Guy Type II by Aer-flo Canvas Products, Inc.
 - 2. Wood Fiber Mulch: EcoFibre by Canfor Corporation.
 - 3. Polyacrylamide Binder: HydroTurboNet by Straw Net, Inc.

Part 3 Execution

3.01 Examination

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to the greatest extent possible.

B. Except in areas to be cleared, do not remove, cut, deface, injure or destroy trees or shrubs without ENGINEER's approval. Protect existing trees or shrubs that are to remain, and which may be injured, bruised, defaced, or otherwise damaged by construction operations, with suitable fences or other means as approved by ENGINEER.

3.02 Preparation

- A. Review the drawings and Storm Water Pollution Prevention Plan (SWPPP).
- B. Revise SWPPP as necessary to address potential pollution from site identified after issuance of the SWPPP at no additional cost to Owner.
- C. Conduct storm water pre-construction meeting with Site Contractor, all grounddisturbing Subcontractors, site Engineer of record or someone from their office familiar with the site and SWPPP, and state or local agency personnel in accordance with requirements of the special conditions.
- D. Schedule work so that the soil surfaces are left exposed for the minimum amount of time. Place permanent soil and sedimentation control measures as soon as practical.

3.03 General

- A. Do not discharge excavation ground water to the sanitary sewer, storm sewer, or to rivers, streams, etc. without authorization from the agency having jurisdiction. Construction site runoff will be prevented from entering any storm drain, river, stream, etc. directly by the use of silt fences or other suitable methods. CONTRACTOR shall provide erosion protection of surrounding soils.
- B. Sedimentation control devices shall be installed prior to CONTRACTOR beginning Work. Soil erosion and sedimentation control devices shall be maintained in an effective functioning condition at all times during the course of the Work.
- C. Immediately bring earthwork to final grade and protect sideslopes and backslopes from erosion. Plan and conduct earthwork to minimize duration of exposure of unprotected soils.

3.04 Installation - General

- A. Install silt fences, ditch sediment traps, check dams, inlet filters, temporary gravel construction entrance/exits, turbidity barriers, erosion control blankets and other soil erosion control devices in accordance with the drawings and Storm Water Pollution Prevention Plan, or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
- B. Deficiencies or changes on the drawings or SWPP shall be corrected or implemented as site conditions change. Changes during construction shall be noted in the SWPP and posted on the drawings.
- C. OWNER has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct CONTRACTOR to provide immediate permanent or temporary pollution control measures.

- D. Remove temporary control devices after permanent measure are established. Remove and replace temporary control devices if they become ineffective at no additional cost to OWNER.
- E. CONTRACTOR shall incorporate permanent erosion control features, paving, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.
- F. CONTRACTOR shall permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.

3.05 Dust Control

A. Keep dust down at all times, including during non-working periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming is not permitted.

3.06 Installation of Erosion Control Blankets

A. Erosion control blankets shall be pegged at the pattern and rate as recommended by the manufacturer, however, at a minimum, blankets shall be pegged at the rate of 1.75 pegs per square yard (2pegs/m²) of blanket, unless otherwise indicated on the plans.

3.07 Application of Bonded Fiber Matrix

- A. The slope shall be prepared and graded prior to application of bonded fiber matrix (BFM). Mixture of wood fiber mulch and polyacrylamide binder shall be blended, with the appropriate amount of seed and fertilizer per Section 32 9219, Seeding, according to manufacturer's recommendations.
- B. BFM shall be hydraulically applied to the soil as a viscous mixture, crating a continuous, three-dimensional blanket that adheres to the soil surface. BFM shall be mixed and applied at the rate as specified in Article 2.06 unless otherwise indicated on the Plans.
- C. The resulting coverage must be at least 1/8 inch (3 mm) thick over the entire surface area. BFM shall be applied in two applications from alternate directions to eliminate shadowing and shall be applied when no rain is expected for 12 hours.

3.08 Dewatering Discharge

- A. Should it be necessary for CONTRACTOR to do any dewatering during the course of construction, CONTRACTOR shall filter all discharge through a discharge filter bag or other sediment control device that will filter all discharge water.
- B. No dewatering discharge shall be allowed to flow unfiltered from the construction site.

3.09 Maintenance

A. Maintain temporary erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or OWNER to control sediment until final stabilization.

B. CONTRACTOR shall respond to maintenance or additional work ordered by OWNER or governing authorities immediately, but in no case, within not more than 48 hours if required at no additional cost to OWNER.

3.10 Inspection

- A. General:
 - 1. CONTRACTOR is responsible to obtain and/or serve as the Certified Operator.
 - 2. Weekly inspections are to be conducted by CONTRACTOR as a minimum, and after every rainfall event. A copy of the inspection report shall be submitted to the agency having jurisdiction, as well as OWNER and ENGINEER.
 - 3. Inspections shall be performed by a person familiar with the site, the nature of the major construction activities, and qualified to evaluate both overall system performance and individual component performance.
 - 4. Inspector must either be someone empowered to implement BMPs in order to increase effectiveness to an acceptable level or someone with the authority to cause such things to happen.
 - 5. Inspector must be certified as a "Storm Water Professional" through the MDEQ storm water training program. Additionally, the inspector shall be properly authorized in accordance with the applicable General Permit to conduct the certified site storm water inspections.
- B. Inspection Frequency Reduction:
 - 1. Inspection frequency may be reduced under the following conditions:
 - a. No active onsite construction activities.
 - b. Temporary cover has been provided across the entire site and no BMPs remain. Situation: waiting for grass to grow, but grass is dormant.
 - c. Ground is frozen and/or snow covered.
 - 2. Weekly Storm Water Meeting:
 - a. A weekly storm water meeting will be held by CONTRACTOR with those involved in ground-disturbing activities to review the requirements of the permits, the SWPPP, and address any problems that have arisen in implementing the SWPPP or maintaining the BMPs.
 - b. CONTRACTOR shall maintain a log of weekly meetings and document the issues addressed in the meetings on site.
 - 3. Agency Storm Water Inspections:
 - a. A log of inspections by federal, state, or local storm water or other environmental agencies shall be kept in CONTRACTOR's SWPPP.

- b. The log form should include the date and time of visit and whether a report was issued or will be issued as a result of the inspection.
- c. Any reports issued will be sent to ENGINEER within 24 hours.

3.11 **Project Completion**

A. Remove temporary soil erosion and sedimentation control devices as soon as permanent measures have been established.

Section 01 6000 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 five (5) feet (1.5 m) 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, CONTRACTOR shall obtain and distribute copies of such instructions to parties involved in the installation including two (2) copies to 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, 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 ENGINEER.

1.05 Contractor's Product Options

- A. For products specified only by reference standard, CONTRACTOR shall select any product meeting that standard.
- B. For products specified by naming several products or manufacturer's 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," CONTRACTOR must submit a Substitution Request Form for any product or manufacturer not specifically named, in accordance with the 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 ENGINEER, in advance of startup, a schedule and listing of startup and testing procedures for review by ENGINEER. Checklists and diagrams may be required to ensure adequate startup and testing. ENGINEER may recommend changes to the startup procedure as necessary.
- D. 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, CONTRACTOR shall train 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 OWNER and ENGINEER.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 7123.26 Construction Survey and Staking

Part 1 General

1.01 Scope of Work

- A. CONTRACTOR shall furnish labor, materials, tools and equipment necessary to perform construction layout, control, and reference staking for satisfactory completion of the project. This includes, but is not limited to:
 - 1. Placing, replacing (if necessary), and maintaining construction layout points;
 - 2. Preparing construction layout drawings, sketches, and computations; and
 - 3. Recording data in field books such as alignment, slope stake, blue top, drainage layout, bridge, and other books used for layout for this Project.

1.02 Submittals

- A. Submit the following documentation in accordance with Section 01 3300:
 - 1. Project Construction Records:
 - a. These records detail information that OWNER/ENGINEER uses to determine the template line for the as-built cross sections, which defines the computation line for unclassified excavation. These records include:
 - (1) Survey records
 - (2) Bound field notebooks
 - (3) Computer printouts that record the Project's construction
 - 2. Survey Documents:
 - a. Furnish the ENGINEER with a copy of survey documents that relate to construction layout. Provide these documents when ENGINEER requests, or as they are completed. ENGINEER may check the documents for accuracy and may require revisions where necessary. The documents become property of OWNER and will be included in the permanent Project records.

1.03 Qualifications

- A. Personnel:
 - 1. Staking shall be performed under the direct supervision of a Land Surveyor licensed by the State in which the Project is located.
 - 2. CONTRACTOR shall furnish personnel, working under the supervision of a Registered Professional Engineer or Registered Land Surveyor, who are fully qualified and capable of establishing or reestablishing line and grade points necessary to complete the work within the generally accepted surveying tolerances, and ensure that they are acceptable for the work being performed.

- B. Equipment:
 - 1. Equipment shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment. Records of repairs, calibration tests, accuracy checks and adjustments shall be maintained and be available for inspection by ENGINEER. Equipment shall be checked, tested, and adjusted as necessary in conformance with manufacturer's recommendations.

Part 2 Products

2.01 Hubs

- A. Hubs shall be $1\frac{1}{2}$ inch x $1\frac{1}{2}$ inch x 16-inch oak and witness stakes shall be 1-inch x 1-inch x 36-inch oak or other hardwood.
- B. Hubs with tacks shall be used for control points, centerline or baseline offsets and structure stakeout and shall be accompanied by witness stakes marked with the pertinent information. For supplemental stakeout only, witness stakes alone may be used. For laser grade control and the verification of the laser elevation a hub with witness shall be provided.

Part 3 Execution

3.01 Preparation

- A. General Pre-Construction:
 - 1. Before beginning construction ensure that plan dimensions, alignment, and elevations are compatible with existing field conditions. Make adjustments where necessary.
 - 2. Ensure alignment tie-ins by coordinating construction layout with that of other Prime Contractors whose work abuts any portion of the work. Adjustments are subject to ENGINEER's approval.

3.02 General

- A. Establish the Centerline:
 - 1. Establish or reestablish the centerline from the monuments and/or reference points OWNER will provide.
 - 2. On widening or reconstruction Projects, establish the horizontal and vertical alignment of the existing roadway and bridges.
 - 3. Modify the Plan horizontal and vertical alignment to conform to the existing alignment as necessary.
- B. Verify the Accuracy of the Benchmark(s):
 - 1. OWNER will furnish at least one benchmark that CONTRACTOR shall preserve, and if necessary, relocate as follows:

- a. Verify the accuracy of the benchmark(s) and report discrepancies to ENGINEER.
- b. Establish additional benchmarks needed for construction.
- c. Maintain the benchmarks for necessary OWNER/ENGINEER checks.
- C. Flag In-Place Survey Control Monuments:
 - 1. Flag and protect in-place survey control monuments and reference points, including Right-of-Way/property line intersections, as follows:
 - a. Pay for and replace destroyed or disturbed stakes or monuments.
 - b. When included as Pay Items, stake Right-of-Way markers.
- D. Line, Grades, and Stakes:
 - 1. Set other line and grade stakes needed to construct the job, including stakes needed to relocate utilities and restake flattened slopes, minor grade or alignment changes, and other incidentals.
- E. Stake Centerline Control Alignments:
 - 1. Stake centerline control alignments shown on the Plans or adjusted as described above when ENGINEER needs accurate measurement of quantities for payment. Stake these control alignments as follows:
 - a. Stake the alignments to an accuracy of 1:5000.
 - b. Stake alignments just before OWNER takes aerial photography or field cross sections for both original and final cross sections.
 - c. Provide OWNER with elevations of positions staked for OWNER's quantity measurements. Ensure that these elevations are of third order accuracy, or better. Determine them using the differential leveling method.
 - d. Take intermediate cross sections required because of stage construction, detours, or other reasons.
- F. Provide Graphic Sketches:
 - 1. Prepare and use graphic sketches of superelevation runout on curves on multilane roadways and of tie-ins of ramps to mainline on freeways and expressways to help provide positive drainage, adequate superelevation, and a pleasing appearance. Prepare and use similar sketches for street or roadway intersections.
- G. Maintain the Stakes:
 - 1. After construction has begun in any segment of the Project, maintain the stakes that identify construction station numbers and locations as follows:

- a. Ensure that stakes are placed at intervals not to exceed 200 ft (60 m) and use even, 100 ft (30 m) stations. Mark and flag stakes so that they are visible to OWNER/ENGINEER in that segment of the Project until construction is complete.
- b. During grading activities in fills or cuts over 20 ft (6 m), extend slope stakes up or down the slopes in intervals of 10 ft (3 m) or less to achieve an accurate cross section.

3.03 Quality Acceptance

A. ENGINEER's acceptance of CONTRACTOR's layout shall not relieve CONTRACTOR of responsibility to secure proper dimensions for the completed work. CONTRACTOR shall, at his own expense, correct work incorrectly located due to layout error.

Section 01 7700 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.
- E. Clean and repaint with matching color scratched, marred or otherwise damaged painted surfaces of equipment and enclosures.

1.02 Project Record Documents

- A. On completion of the Work, prior to CONTRACTOR's application for final payment, and as a condition to its approval by ENGINEER and OWNER, CONTRACTOR shall arrange such site records in order in accordance with the various sections of the specifications bind them together and index them and deliver them to ENGINEER.
- B. CONTRACTOR shall request a complete set of reproducible Contract Drawings and transfer all as-built revisions and changes to them and deliver them to the ENGINEER. These drawings shall be dated and marked "RECORD DOCUMENTS".
- C. Reproducible tracings made by CONTRACTOR, Subcontractors, equipment manufacturers, and/or Suppliers shall be corrected to show the Work as actually completed or installed and a reproducible copy of these drawings shall then be turned over to ENGINEER.
- D. Written approval or other evidence satisfactory to ENGINEER of the final conditions of the work shall be obtained from:
 - 1. Public authorities or agencies having jurisdiction over any portion of the work
 - 2. Others as requested by ENGINEER in writing.
- E. Public authorities or agencies having jurisdiction over any part of the work shall be determined, and all the requirements of these authorities or agencies with respect to but not limited to inspection, permits, fees, approval, and the like regardless of whether they are listed above or not shall be met.
- F. CONTRACTOR shall deliver one (1) copy of all Specifications, Plans, Addenda, Shop Drawings, Samples, Certificates, approvals, etc. annotated to show all changes made during the construction process, to ENGINEER upon completion of the Work and prior to CONTRACTOR's application for final payment. 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
- 6. 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 3300, Submittal Procedures, shall constitute the basis of such instruction.

1.04 Spare Parts and Special Tools

- A. Spare Parts:
 - 1. As soon as practicable after approval of the list of equipment, CONTRACTOR shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit prices and source of supply.
 - 2. CONTRACTOR shall also furnish a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified to be furnished a part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation for a period of one (1) year at the particular installation.
 - 3. The foregoing shall not relieve CONTRACTOR of any responsibilities under the guarantee provisions of these Specifications.
 - 4. CONTRACTOR shall deliver all spare parts required by this contract to ENGINEER or as directed by ENGINEER.
- B. Special Tools:
 - 1. CONTRACTOR shall furnish at no additional cost to OWNER with each piece of equipment, one complete set of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.
 - 2. CONTRACTOR shall submit for approval by ENGINEER a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.
 - 3. CONTRACTOR shall deliver all special tools required by this contract to ENGINEER or as directed by ENGINEER.

1.05 Start Up

- A. Equipment start-up period for the training of plant personnel shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for that part of the work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the work, the period shall begin upon substantial completion of the project.
- B. During the equipment start-up period, CONTRACTOR shall furnish at no additional cost to OWNER the services of factory trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
 - 1. Assist in the start-up and operations of the equipment.
 - 2. Assist in the training of facility personnel, designated by OWNER, in the proper operation and maintenance of the equipment.
- C. OWNER shall:
 - 1. Provide the necessary personnel to be instructed in the operation and maintenance of the equipment. OWNER's personnel shall operate all equipment.
 - 2. Pay for all fuel, power and chemicals consumed beyond quantities specified or in the Contract Documents or required due to CONTRACTORs fault. CONTRACTOR shall pay for fuel, power, and chemicals consumed up to the date of "certified substantial completion" except as otherwise specified herein.
- D. CONTRACTOR shall be available to promptly repair all work during the start-up period so as to cause minimum disruption to the total facility operation.
- E. In the event a system, equipment, or component proves defective or is unable to meet specified performance criteria, CONTRACTOR shall replace the defective item and the one (1) year guarantee period for the item shall start after satisfactory replacement and testing of the item.

1.06 Substantial Completion

- A. When CONTRACTOR considers that the Work, or portion thereof which the OWNER agrees to accept separately, is substantially complete, the CONTRACTOR shall prepare and submit to ENGINEER a comprehensive list of items to be completed or corrected.
- B. CONTRACTOR shall proceed promptly to complete and correct items on the list. Failure to include an item on such list does not alter the responsibility of CONTRACTOR to complete all Work in accordance with the Contract Documents.
- C. Upon receipt of CONTRACTOR's list, ENGINEER will make an inspection to determine whether the Work or designated portion thereof is substantially complete.
- D. If ENGINEER's inspection discloses any item, whether or not included on CONTRACTOR's list, which is not in accordance with the requirements of the Contract Documents, CONTRACTOR shall complete or correct such item upon notification by ENGINEER. CONTRACTOR shall then submit a request for another inspection by ENGINEER to determine Substantial Completion.

- E. When the Work or designated portion thereof is substantially complete, ENGINEER will prepare a Certificate of Substantial Completion which shall establish responsibilities of OWNER and CONTRACTOR for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the CONTRACTOR shall finish all items on the list accompanying the Certificate. The Certificate of Substantial Completion shall be submitted to OWNER and CONTRACTOR for their written acceptance of responsibilities assigned to them in such Certificate.
- F. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

1.07 Warranties

- A. CONTRACTOR shall submit duplicate copies of all warranties prior to final Application for Payment. CONTRACTOR shall also execute, assemble and submit transferable warranty documents from Subcontractors, suppliers, and manufacturers.
- B. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.
- C. All parts of the work or equipment which is in the opinion of ENGINEER prove defective in material, workmanship, or operation within the warranty period shall be removed and replaced or repaired in a manner satisfactory to ENGINEER and at no cost to OWNER.
- D. Service material or equipment required because of the defect shall be supplied without charge.
- E. Work specified to be designed by CONTRACTOR shall be guaranteed to perform as specified.
- F. Warranty period shall be one year from the date of Substantial Completion unless:
 - 1. a greater period is specified elsewhere.
 - 2. OWNER chooses to take over and use a portion of the Work as provided for in the Specifications; in which case the warranty shall be one (1) year from said takeover and use.
- G. Equipment or work replaced and/or repaired during the warranty period shall be guaranteed for one year from the date of acceptance of the repair or replacement or until expiration of the original warranty period whichever comes later.

1.08 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)

Section 01 7900 Demonstration and Training

Part 1 General

1.01 Requirements Included

- A. Instruct and train OWNER's personnel in maintenance and operation of equipment for systems supplied and/or installed under this Contract, including the following items:
 - 1. Process, mechanical, service and other equipment as noted in the detailed specifications.
 - 2. System instrumentation.
 - 3. Primary switchgear.
 - 4. Motor control centers.
- B. Incorporate the following maintenance and operation data and training services into the training program:
 - 1. Shop Drawings.
 - 2. Equipment Operation and Maintenance Manuals.
- C. Prepare instruction training materials, and student notes/guides for complete classroom and hands-on training of all individuals requiring training.

1.02 Related Requirements

- 1. Section 01 3300: Submittal Procedures
- 2. Section 01 7700: Closeout Procedures
- 3. Section 11 0500: Common Work Results for Equipment
- 4. Division 26, Electrical
- 5. Division 40, Process Interconnections

1.03 Quality Assurance

A. Preparations of training materials and instruction to be provided shall be performed by personnel trained and experienced in maintenance and operation of equipment and systems to be installed under this Contract.

1.04 Schedule of Conducting Training

- A. Classroom and field training programs shall be conducted after performance testing begins but prior to substantial completion.
- B. Training programs shall be planned and conducted for:
 - 1. Operations Personnel.
 - 2. Maintenance Personnel.

C. Scheduling shall be coordinated through ENGINEER.

1.05 Training for Maintenance of Instrumentation

- A. Train OWNER's maintenance personnel as follows:
 - 1. Describe the overall function of each instrument and control loop installed under this Contract.
 - 2. Locating the probable source of malfunction in the instrumentation equipment and control loops, determining the symptoms of the trouble, establishing the probable cause and effecting a solution.
 - 3. Taking appropriate, preventive, and corrective maintenance procedures necessary to keep the instrumentation system in proper operating condition, including calibration and testing.
- B. Course materials to be used for training OWNER's maintenance personnel shall include pertinent portions of the submittals specified in the Specifications such as loop diagrams, calibration data, trouble-shooting guides and maintenance instructions.
- C. The training program shall not include the time required for system start-up instructions or the field acceptance test.

1.06 Training for Electrical and Mechanical Maintenance

- A. Train OWNER's maintenance personnel as follows:
 - 1. Describe the functions of the equipment installed under this Contract.
 - 2. Component preventive and corrective maintenance activities required to keep unit equipment in good operating conditions.
 - 3. The Contractor shall instruct the personnel in locating the probable source of equipment malfunctions, determining the symptoms of the trouble, establishing the probable cause, and effecting a solution.
- B. Course materials to be used for training OWNER's electrical and mechanical maintenance personnel to include pertinent portions of the operation and maintenance manuals as well as alignment tolerances, lubrication schedules, vibration analysis instruction and parameters, trouble-shooting guides and special calibration test and procedures.
- C. Method of training electrical and/or mechanical maintenance personnel shall include CONTRACTOR using OWNER's equipment to demonstrate troubleshooting, preventive and corrective maintenance procedures.
- D. The field training program shall not include the time required for system start-up instructions or the acceptance test.

1.07 Operational Training

A. Train OWNER's operations personnel as follows:

- 1. Describe the functions of the equipment installed under this Contract, including how the components of a system are controlled together and what the effects of the control methods are on the system and on other upstream and downstream processes installed under this Contract.
- 2. Implement start-up and shutdown procedures for each piece of equipment individually, as well as the start-up and shutdown of the systems comprising the equipment. This instruction shall include normal operation, alternative operations, and emergency operations.
- 3. Understand the functions of the equipment installed under this Contract, describing the individual components and how each component is used in monitoring and/or controlling equipment and/or processes installed under this Contract.
- 4. Discuss the operating modes possible as a result of the modifications and installations made under this Contract.
- 5. Locating the probable source of system trouble determining the symptoms, establishing the probable cause, and re-stabilizing system efficiency or systems installed under this contract.
- 6. Demonstrate necessary precautions for safe operation of the equipment, instrumentation, and control system installed under this Contract.
- 7. Demonstrate emergency procedures for equipment and systems installed under this Contract.
- B. Course materials to be used for training OWNER's operation personnel include pertinent portions of the Operations and Maintenance Manuals, including start-up and shutdown procedures; descriptions of equipment and instrumentation functions and modes of operations, control and monitoring; trouble-shooting instructions and process control instructions.
- C. Methods of training OWNER's operations personnel shall include a field training program at OWNER's site consisting of classrooms and hands-on training using OWNER's equipment and systems.
- D. The field training program shall not include the time required for system start-up instructions or the field acceptance test.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 8813 Special Construction Performance Requirements

Part 1 General

1.01 Summary

- A. CONTRACTOR shall be totally responsible for the construction of the Project under scheduling conditions outlined herein and any other scheduling which may be necessary.
- B. Work shall be completed for the lump sum price submitted in CONTRACTOR's proposal. No additional compensation will be allowed for delays in the work necessary to prevent interruption of service whether specifically spelled out in this section or not.
- C. CONTRACTOR shall note the construction site area limitations as they impact on storage of excavated and construction materials. CONTRACTOR shall make all necessary provisions for off-site storage as required for his operations. Costs for this work including permits, shall be included in CONTRACTOR's lump sum price bid. Prior to commencement of site excavation, CONTRACTOR shall provide the names and locations of the offsite disposal and storage area to be used for excess excavated materials.
- D. CONTRACTOR shall notify OWNER prior to any work being conducted outside of normal business hours and shall provide notification to OWNER's personnel when workers are on site.

1.02 Coordination

- A. Prior to commencing any work on any excavation of the site, temporary construction fencing shall be installed to protect the area. The temporary fence shall be 6'-0" high chain link fence. Fencing shall be removed when final grading and site restoration begins.
- B. Restoration of the site shall be done strictly according to the requirements of these plans and specifications, under the coordination and direction of a specialist in this field. CONTRACTOR is responsible for watering, fertilizing or other care required by the plantings for one year from the date of their acceptance by OWNER.
- C. Equipment and the facilities shall be tested prior to being accepted by OWNER. Testing shall be conducted in the presence of OWNER's representative. Equipment and the facilities shall then be cleaned and turned over to OWNER in good working order.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 01 8900 Site Construction Performance Requirements

Part 1 General

1.01 Scope of Work

A. This Section includes general performance requirements for earthwork complete with, reimbursement for crop damage, 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 5713: Temporary Erosion and Sediment Control
- B. Section 01 8933: Bypass Pumping
- C. Section 31 2200: Grading
- D. Section 31 2313: Subgrade Preparation
- E. Section 31 2319: Dewatering
- F. Section 31 2333: Trenching and Backfilling
- G. Section 32 1216: Bituminous Paving
- H. Section 32 1315: Sidewalks and Driveways
- I. Section 32 9219: Seeding

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.

1.04 Requirements of Regulatory Agencies

- A. CONTRACTOR shall comply with Section01 5713, Temporary Erosion and Sediment Control. CONTRACTOR, at his 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 ENGINEER.
 - 1. 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 ENGINEER.

1.06 Protection of Plant Life

- A. Trees, shrubs, and other types of vegetation not within the limits of the Work or not designated on the Plans or by 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 CONTRACTOR's operation shall be repaired or replaced by CONTRACTOR, at his expense, as determined by 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 CONTRACTOR's operations shall be repaired or replaced by the CONTRACTOR, to the satisfaction of the owner, at his expense.
- C. Deposits of dirt or debris in sewers, culverts, tiles, drainage structures, manholes, gate wells, etc. caused by 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 of MDOT Section 902.

Part 3 Execution

3.01 General

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

3.02 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. Costs incurred for furnishing, installing, maintaining and removing the dewatering equipment shall be at CONTRACTOR's expense.
- C. Refer to Section 31 2319, Dewatering, for additional requirements.

3.03 Existing Improvements

A. CONTRACTOR shall expose existing sewers and structures to which the new Work is to be connected and notify ENGINEER of same. ENGINEER will verify the vertical and horizontal locations of the existing system and shall inform 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 Miss Dig 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, CONTRACTOR, at his expense, shall perform his 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, CONTRACTOR shall make all arrangements with OWNER of the utility for the moving. costs incurred for such moving shall be at CONTRACTOR's expense unless indicated otherwise. However, before disturbing a utility line, structure or pole, CONTRACTOR shall furnish 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, CONTRACTOR shall provide 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 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. New material shall be installed as specified in the Contract Documents and per the requirements of the local agencies. Bedding and backfill material, unless otherwise specified, shall be an approved Class II granular material, compacted to 98% 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. Relocation or protection of existing sewers, tiles, tile field, water mains or building services and leads shall be at 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.

Neither the correctness nor completeness of such information is guaranteed or implied.

B. Structures shall be protected, preserved or restored by 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 CONTRACTOR, at his expense, to protect the structures.
- B. When it becomes necessary for CONTRACTOR to move one of these buildings or structures in order to proceed with construction, CONTRACTOR, at his 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, CONTRACTOR shall furnish 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, CONTRACTOR, at his 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, ONTRACTOR shall install a masonry bulkhead in the structure.
- C. Removal of a culvert or sewer also includes the removal and disposal of end treatments or headwalls.

3.10 Removal of Structures

- A. 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 98% 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 ENGINEER, shall be installed and maintained by the CONTRACTOR, during the rebuilding period.

3.11 Abandoning Structures

- A. Structure shall be broken down to at least 30 inches (750 mm) below the subgrade.
- B. Pipes connected to the structure shall be plugged with a brick, masonry or concrete bulkhead approved by ENGINEER.
- C. Structure shall be backfilled with flowable fill to 1-foot (300 mm) 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 1-foot (300 mm) below finished grade.
- D. The remainder of the excavation shall be backfilled with a granular material, compacted to 98% of its unit weight, and shall meet with the approval of ENGINEER.
- E. Maximum unit weight shall be determined by ASTM D698, Method B.

3.12 Salvaged Material

A. Salvaged materials shall become the property of CONTRACTOR unless otherwise specified in the Contract Documents, and shall be disposed of by CONTRACTOR, at his expense.

3.13 Trees

- A. Trees excepting those specified on the Plans to be removed, shall be effectively protected by CONTRACTOR during his construction operations.
 - 1. If in the opinion of ENGINEER, the methods of protection employed by CONTRACTOR are not adequate, CONTRACTOR shall carry on his operation by tunneling, or by other approved means, which will not cause undue damage to the trees.
- B. The requirements for tree tunneling are as follows:

- 1. Depth of Cover:
 - a. Tunnels shall be placed at a minimum depth of 30 inches (0.75 m), measured from the ground surface to the top of the tunnel.
- 2. Length of Tunnel:
 - a. Tunnel length in feet (meters) shall be in direct proportion to diameter of tree in inches (millimeters) for trees eight (8) inches (200 mm) or larger in diameter. One (1) foot of tunnel shall be constructed for each inch of tree diameter whenever the trench or any portion thereof approaches the tree trunk a distance in feet equal to one-half the tree diameter in inches.
 - b. Example: A tree 12 inches in diameter shall require a 12-foot tunnel whenever the trench or any portion thereof approaches within six (6) feet of said tree.
- 3. Measurements:
 - a. Trees under 8 inches in diameter will require the same length of tunnel as 8-inch trees. Measurements of tree diameters shall be taken four (4) feet above the ground surface.
- C. Where the Plans indicate areas allowing the cutting of minor trees, care should be used to keep damage to adjacent trees to an absolute minimum. Where these areas are specifically indicated on the Plan, they are to be cleared and all trunks and branches shall be disposed of by CONTRACTOR. Debris shall not be bulldozed on to adjacent private property.
- D. Trees damaged by the construction operation shall be repaired so not to inhibit growth or replaced at the expense of CONTRACTOR. Repair or replacement shall be contingent upon agreement between the damaged tree owner and CONTRACTOR. In any event, limbs, branches and roots damaged by CONTRACTOR shall be properly pruned to the satisfaction of ENGINEER.
- E. Costs incurred for protection of trees, including tunneling, repair and replacement, if necessary, shall be at CONTRACTOR's expense.

3.14 Removing Pavement

- A. 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. Pavement shall be removed to an existing joint or cut parallel to the existing pavement joints.
- C. Cutting shall be accomplished by using a power-driven concrete saw approved by ENGINEER. Depth of the saw cut shall be a minimum of 6-inches, to ensure 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 five 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 ENGINEER along a line parallel to and at least one foot 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.
 - 1. Removal of Curb for Curb Drop:
 - a. Where curb is to be removed for a curb drop, the operation shall be performed by saw cutting or by cold milling, approved by ENGINEER, so as to leave a neat surface with a maximum 1-inch lip, without damage to the underlying pavement.
 - 2. Removal of Curb and Gutter:
 - a. 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 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.
- G. 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 CONTRACTOR's expense.
- H. 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 ENGINEER, at CONTRACTOR's expense.

3.15 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. Material shall be placed by the controlled density method or other effective means having the approval of ENGINEER and shall be compacted to 95% of maximum unit weight.
- B. Furnishing, placing and compacting of the backfill material shall be at CONTRACTOR's expense.

3.16 Restoration in Right-of-Way and Yard Areas

- A. 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. Disturbed areas may be shaped by "Machine Grading" or another method approved by 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 CONTRACTOR at his expense.

- C. Disturbed areas shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding, or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place, and compact any additional fill, meeting the approval of ENGINEER, needed to restore the disturbed areas to the cross sections called for on the Plans or as determined by ENGINEER.

3.17 Restoration of Aggregate Surfaces

- A. Shoulders:
 - 1. 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. 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." 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 his 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. 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. Aggregate surfaced areas beyond the limits of the actual excavation which are disturbed, as determined by ENGINEER, by such operations as temporary storage of materials or passage of equipment, shall be resurfaced, at CONTRACTOR's expense.
 - a. Upper 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 compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per Ton of aggregate
 - 4. CONTRACTOR, at his 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." The remaining depth shall be backfilled with two 6-inch layers of compacted 22A or 23A aggregate, with calcium chloride applied at the rate of 6 pounds per Ton of aggregate.
- 2. CONTRACTOR, at his 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 all aggregate shall be performed by a pneumatic-tired roller or a vibratory compactor until the material forms a stable surface.

3.18 Restoration of Paved Surfaces

- A. CONTRACTOR, at his expense, shall 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. 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"
 - 2. Unless otherwise specified on the Plans or as determined by ENGINEER, the concrete removed shall be replaced with 3,500 psi concrete of the thickness removed and shall include reinforcing equal to the existing, if the existing pavement was reinforced.
 - a. The construction of concrete pavements shall be in accordance with Section 32 1313, Concrete Paving.
 - 3. 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 Act 8, Michigan PA 1973, as amended and to Section 32 1315, Sidewalks and Driveways, and unless otherwise indicated in the Proposal, shall be considered incidental to the Project.

D. Bituminous:

1. 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."

- 2. Bituminous pavement or bituminous surface course with an aggregate base shall be replaced in accordance with Section 32 1216, Bituminous Paving.
- 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 ENGINEER, shall include complete replacement full width and length (extending a minimum of 25 linear 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 1216, Bituminous Paving.

3.19 Soil Erosion and Sedimentation Control

- A. CONTRACTOR shall comply with the requirements of Section 01 5713, Temporary Erosion and Sediment Control. Prior to commencing any type of earthwork, CONTRACTOR shall obtain a Soil Erosion and Sedimentation Control permit from the local enforcing Agency.
- B. CONTRACTOR, at his expense, 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 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.

3.20 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 OWNER, shall transport all excess excavation to a site(s) designated by OWNER.
 - 1. Excess excavation shall be graded by 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 (± 0.25 foot).
- C. When the excess excavation has not been requested by e OWNER, CONTRACTOR shall remove and properly dispose of the material at no additional cost to 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 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.
Section 01 8933 Temporary Bypass Pumping

Part 1 General

1.01 Work Summary

- A. CONTRACTOR shall provide a complete sewer bypassing system including, but not limited to, the following:
 - 1. Developing a sewer bypassing plan
 - 2. Developing a spill prevention and emergency response plan
 - 3. Submitting and obtaining approval from ENGINEER/OWNER for the sewer bypassing plan and the spill prevention and emergency response plan.
 - 4. Implementing the bypassing and spill prevention and emergency response plan.
 - 5. Providing bypassing in accordance with the approved plans throughout the duration of the Work where bypass pumping is required.

1.02 Related Work Specified Elsewhere

- A. Section 01 1213: Work Sequence
- B. Section 01 3300: Submittal Procedures
- C. Section 33 3400: Sanitary Utility Force Mains
- D. Section 33 3410: High Density Polyethylene (HDPE) Pipe and Fittings
- E. Section 33 3410.15: Leakage Testing for High Density Polyethylene Pipe

1.03 System Description

- A. Flow control during construction shall be provided to meet the minimum flow rate(s) as listed on Schedule and shall perform reliably and continuously to provide uninterrupted sanitary service during the execution of the Work.
- B. Provide temporary flow control facilities that can be installed, operated, maintained, and removed without damage to existing structures.
 - 1. Under no circumstances shall sewage or solids be deposited onto the ground surface, streets, or into ditches, catch basins or storm drains, or natural drainage ways.
 - 2. In the event that the sewage backup occurs and enters dwellings or other structures, CONTRACTOR shall be responsible for clean-up, repair, property damage costs, fines imposed by jurisdictional authorities, and claims arising therefrom.
 - 3. Spills shall be contained and returned to the sewer system unless the pumped liquid is approved by the authorities having proper jurisdiction to be discharged to surface waters of the State.

1.04 Submittals

- A. Flow Control Plan: Submit in accordance with Section 01 3300, Submittal Procedures, covering the items included under this Section. Submittal shall include:
 - 1. Schedule for installation and maintenance of bypass pumping system.
 - 2. Staging areas for pumps.
 - 3. Bypass pump sizes, capacity, number of each size to be on site and power requirements.
 - 4. Calculations of static lift, friction losses, and flow velocity
 - 5. Pump curves showing pump operating range.
 - 6. Protection against main breaks.
 - 7. Sewer plugging methods and bypass time duration for each sewer section.
 - 8. Size, length, material, location and method of installation for suction and discharge piping.
 - 9. Include tapping procedures.
 - 10. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill.
 - 11. Method of noise control for each pump and/or generator.
 - 12. Standby power generator size and location.
 - 13. Downstream discharging plan.
 - 14. Methods of protecting discharge manholes or structures from erosion and damage.
 - 15. Restraining lengths for piping. Thrust blocks will not be allowed as a method of restraint for bypass pumping systems.
 - 16. Location of fuel tank(s) and other potential contaminants.
 - 17. Control and reliability methods including float switches, visual and audible alarms, and pump controls.
 - 18. Overflow Prevention, Containment and Cleanup Plan.
- B. Emergency Personnel: Provide at least 2 contacts who can be contacted 24 hours per day by phone to address emergencies, along with their names, phone numbers, and working schedules. List shall be updated if there are any substitutions at least 2 days in advance. These contacts shall be connected to the control system automatic dialer (or equivalent).

1.05 Quality Assurance

A. Qualifications: Firms regularly engaged in bypass pumping systems, of types and sizes required, and whose systems have been used with successful results in similar service for not less than 5 years.

1.06 Sequencing

A. Refer to Section 01 1213, Work Sequence, for sequence of construction requirements.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with specified requirements, the temporary flow control bypass pumping companies offering services which may be used as part of the Work include:
 - 1. Mersino Dewatering, Inc.
 - 2. Thompson Pump Midwest
 - 3. ENGINEER-approved equal

2.02 Performance Requirements

- A. It is essential to the operation of the existing sewerage system that there is no interruption in the flow of sewage throughout the duration of the project.
- B. CONTRACTOR shall provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with work, carry it past the work area, and return it to the existing sewer downstream of the Work area.

2.03 Design Requirements

- A. Bypass pumping system shall be designed to provide adequate capacity for peak flows around the Work area as necessary for satisfactory performance of the Work.
- B. CONTRACTOR shall provide pipeline plugs, pumps and temporary discharge piping to ensure that the total flow of the main can be safely diverted.
- C. Bypass pumping system may be required to be operated 24 hours a day. CONTRACTOR shall provide necessary monitoring devices to notify CONTRACTOR of any pump failure.
- D. CONTRACTOR shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each pump size utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.
- E. Design, installation, and operation of the temporary pumping system shall be CONTRACTOR's responsibility.
- F. Bypass system shall meet the requirements of local, State, and Federal codes and regulations.
- G. CONTRACTOR shall not be permitted to stop or impede the main flows under any circumstances.
- H. CONTRACTOR shall maintain sewer flow around the Work area in a manner that will not cause surcharging of sewers, damage to sewers, and that will protect public and private property from damage and flooding.
- I. CONTRACTOR shall protect water resources, wetlands, and other natural resources.

2.04 Components

- A. Pumps:
 - 1. No electric pumps will be allowed; pumps must be diesel powered.
 - 2. Pumps shall be specifically intended for use with raw sewage and shall be capable of passing a 3-inch diameter solid.
 - 3. Pumps used for sewer bypassing shall be the submersible type and shall only be operated below ground in the sewer manhole or other sewer facility. The use of above ground pumps or pumps not specifically designed for submersible service are not allowed.
 - 4. Pumps shall be sized to fit in manholes or other confined areas necessary to successfully complete the sewer bypassing. CONTRACTOR shall ensure equipment used for bypassing will operate under the conditions required and CONTRACTOR will be responsible for costs associated with changes to the bypassing system due to inappropriate equipment or non-conformance with the Contract Documents.
 - 5. Pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric, or diesel powered. Pumps used must be constructed to allow dry running for long periods of time to account for the cyclical nature of effluent flows.
 - 6. CONTRACTOR shall provide the necessary stop/start controls for each pump.
 - 7. CONTRACTOR shall include one stand-by pump for each size to be maintained on site. Back-up pumps shall be on-line, isolated from the primary system by a valve.
 - 8. CONTRACTOR shall provide an emergency standby power generator, sized to operate the bypass system at a minimum, to be used to operate the submersible pumps if electrical power is lost during the progress of the Work and a sewage spill will occur.
- B. Piping:
 - 1. Discharge and suction piping sizing shall be determined according to flow calculations and system operating calculations. Provide piping designed to withstand minimum 1.5 times the maximum system pressure.
 - 2. HDPE piping shall be in accordance with Section 33 3410, High Density Polyethylene (HDPE) Pipe and Fittings.
 - 3. Rigid or hard piping shall be constructed with positive restrained joints.
 - 4. Piping shall be maintained in a watertight condition and leaks shall be immediately repaired.
- C. Flexible Hose:
 - 1. Flexible hose and couplings shall be abrasive resistant and suitable for the intended services (i.e., fire hoses are not permitted).

- 2. Flexible hose and couplings shall be rated for external and internal loads anticipated including test pressure.
- 3. External load design shall incorporate anticipated traffic loadings, including traffic impact loading where applicable. When subjected to traffic loading, the system shall be composed of traffic ramps and covers maintaining an H20 loading requirement while in use or as directed by OWNER.
- D. System Controls:
 - 1. CONTRACTOR shall continuously (while in use) monitor the operation of the bypass system and impacted facilities. CONTRACTOR shall submit, as part of their bypass plan, their system monitoring procedure and frequency. CONTRACTOR shall maintain a log of the monitoring in a manner acceptable to ENGINEER.
 - 2. Control panel(s) equipped with necessary fused-switch combination starters, control transformer, Start-Stop controls, cycle controls, variable speed drive controls, and alarm systems. Provide all necessary relays, timers, interlocks, and control devices. If mounted outdoors enclosure shall be minimum NEMA.4.
 - a. Level controls such as float switches, pressure transducers, or level sensors along with the necessary wiring back to the temporary control panel shall be provided as required.
 - b. In lieu of providing manpower to continuously monitor the pumping equipment on a 24-hour basis a dialer may be provided that will alert CONTRACTOR when an alarm condition exists. CONTRACTOR shall make arrangements to obtain temporary phone service for dialer system or the dialer shall be connected to the plant operating system if shown.
 - c. Automatic switch over capabilities shall be provided to activate standby equipment.
 - d. Alarm when stand by equipment is operating.
 - e. Alarm when aeration tank effluent channel is outside of normal operating range.
 - f. Alarm when there is a power outage.
 - g. Alarm status indication consisting of alarm light, mounted in an easily visible location.
 - h. If shown the temporary flow control system shall be wired into the Plant's electronic operation and control system.
 - i. Provide temporary lighting available for 24-hour per day pumping operations to aid with reliable system operation, maintenance and safety of personal.

Part 3 Execution

3.01 Preparation

- A. Existing Utilities:
 - 1. CONTRACTOR is responsible for locating any existing utilities in the area CONTRACTOR selects to locate the bypass pipelines.
 - 2. CONTRACTOR shall locate bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from OWNER.
 - 3. Costs associated with relocating utilities and obtaining approvals shall be the responsibility of CONTRACTOR.
- B. Precautions:
 - 1. During all bypass pumping operation, CONTRACTOR shall protect the pumping station, main and all local sewer lines from damage inflicted by any equipment.
 - 2. CONTRACTOR shall be responsible for any physical damage to the pump station and main and all local sewer lines caused by human or mechanical failure.

3.02 Installation and Removal

- A. CONTRACTOR shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only at the access locations indicated on the bypass pumping plan.
- B. Plugging or blocking of sewage flows shall incorporate primary and secondary plugging devices. When plugging or blocking is no longer needed for performance and acceptance of Work, the plugging or blocking shall be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging, and/or causing other major disturbances downstream.
- C. When working inside a manhole or force main, CONTRACTOR shall exercise caution and comply with MIOSHA requirements for working in the presence of sewer gases, combustible oxygen-deficient atmospheres, and confined spaces.
- D. The bypass pipeline shall be located off streets sidewalks, and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, CONTRACTOR shall place the bypass line in trenches and cover with temporary pavement or shall install the bypass pipeline by trenchless installation methods.
- E. CONTRACTOR is responsible for obtaining any approvals for placement of temporary pipelines from local agencies.
- F. Upon completion of the bypass pumping operations, and after the receipt of written permission from OWNER, CONTRACTOR shall remove all piping, restore property to pre-construction condition, and restore pavement, sidewalks and/or roadways affected by bypass pumping operations.

3.03 Field Quality Control and Maintenance

- A. CONTRACTOR shall perform leakage and pressure tests of the bypass pumping system after the equipment has been installed to demonstrate the system is in good working order, the units have been properly installed, will operate satisfactorily, and meet the specified conditions.
 - 1. Clean water shall be used for testing.
 - 2. CONTRACTOR shall give OWNER 24 hours' notice prior to testing.
- B. CONTRACTOR shall ensure that the temporary pumping system is properly maintained, and a responsible operator shall be on hand at all times when pump(s) is operating.
- C. Unless otherwise approved in the Flow Control Plan, there shall be minimum one responsible person or combination of responsible people available 24 hours per day to respond immediately and arrive onsite within 15 minutes to monitor and maintain the bypass and implement the emergency procedures if necessary. At a minimum, CONTRACTOR shall inspect bypass pumping system every 2 hours to ensure that the system is working properly.
- D. CONTRACTOR shall immediately notify OWNER and ENGINEER if a sanitary sewage overflow occurs and take the necessary action to clean up and disinfect the spillage to the satisfaction of OWNER or other governmental agencies.
 - 1. If sewage is spilled onto public or private property, CONTRACTOR shall wash down, clean up, and disinfect the spillage to the satisfaction of the property owner.
 - 2. In the event that sewage backup occurs and enters dwellings or other structures, CONTRACTOR shall be responsible for clean-up, repair, property damage costs, fines imposed by jurisdictional authorities, and claims arising therefrom. Spills shall be contained and returned to the sewer system.
- E. Spare parts and materials for pumps and piping shall be kept onsite, as required.
- F. Adequate hoisting equipment for each pump and accessories shall be maintained onsite.

3.04 Bypass Pumping Schedule

A. General:

| 1. | Total Bypass Capacity: | 50 MGD |
|----|-------------------------------------|---|
| 2. | Minimum No. Electric Pumping Units: | 2 |
| 3. | Minimum No. Standby Pumping Units: | 1 |
| 4. | Pump Type: | Submersible; Diesel-powered |
| 5. | Flow Stream to Be Bypassed: | Raw Sanitary Sewage |
| 6. | Pump From: | Wet Well (north of Screening Building)* |
| 7. | Pump To: | Line Stop in 72-inch Force Main* |
| | | |

*Refer to Contract Drawings for more information.

End of Section

Division 02 Existing Conditions

Section 02 4100 Demolition

Part 1 General

1.01 Section includes

- A. Building/concrete structure demolition.
- B. Selective demolition of building elements for alterations purposes.
- C. Selective demolition of mechanical equipment.
- D. Selective demolition of electrical equipment.
- E. Abandonment and removal of existing utilities and utility structures.
- F. Salvage of existing items to be reused or delivered to Owner.

1.02 Reference Standards

- A. 29 CFR 1926 U.S. Occupational Safety and Health Standards.
- B. NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations.
- C. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, current edition.

1.03 Definitions

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to OWNER ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 Submittals

- A. Submit in accordance with Section 01 3300.
- B. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of OWNER's operations. Sequence shall be compatible with overall work sequence of construction.
- C. Health and Safety Plan (HASP). Submit a HASP for workers exposed to sewage sludge materials or other hazards as part of this work.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 Quality Assurance

A. Demolition Firm Qualifications: Company specializing in the type of work required.

B. The Michigan Building Code shall control the demolition, modification or alteration of the existing buildings or structures.

1.06 **Project Conditions**

- A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- B. This project is in a municipal wastewater treatment plant. The work will involve contact with sewage sludge which contains pathogens and other bacteria which can affect human health. Proper care and protection for all workers coming in contact with these materials is the responsibility of CONTRACTOR. A Health and Safety Plan shall be prepared by CONTRACTOR for this purpose.
- C. Erect and maintain barriers, lights and other protective devices to prevent access to areas under construction or within the influence of the ongoing work. Provide free and safe passage to and from adjacent structures which are being used by OWNER for ongoing operations of the treatment plant.
- D. OWNER and ENGINEER assume no responsibility for the actual condition of the structures/equipment to be demolished or modified. Conditions existing at the time of inspection for bidding purposes will be maintained by OWNER insofar as practicable. However, variations within a structure may occur prior to the start of demolition work.
- E. Promptly repair damage caused to adjacent facilities by demolition operation when directed by the ENGINEER at no cost to OWNER. Repairs shall be made to a condition at least equal to that which existed prior to construction.

1.07 Contractor's Supervision

- A. CONTRACTOR's responsibility shall include a completely equipped first aid kit, provided and maintained at the site in a clean orderly condition and shall be readily accessible at all times to CONTRACTOR's employees.
- B. CONTRACTOR shall designate certain employees who are properly instructed to be in charge of first aid. At least one such employee shall be available whenever work is in progress at the demolition site.
- C. Telephone call lists for summoning aids from outside sources, such as doctors, ambulances, and rescue squads, shall be conspicuously posted at the site.

1.08 Warranty

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

Part 2 Products (Not Used)

Part 3 Execution

3.01 General Procedures and Project Conditions

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.

- 2. Comply with applicable requirements of NFPA 241.
- 3. Use of explosives is not permitted.
- 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
- 5. Provide, erect, and maintain temporary barriers and security devices.
- 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
- 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
- 8. Do not close or obstruct roadways or sidewalks without permit.
- 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
- B. Do not begin removal until receipt of notification to proceed from OWNER.
- C. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 - 2. Protect items from damage during transport and storage.
 - 3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
 - 4. No jackhammering or other destructive methods of construction shall be used in areas where adjacent facilities which are to remain and which may be damaged by such operations exist unless approved prior by ENGINEER.
- E. Partial Removal of Paving, Concrete structures and Curbs: Neatly saw cut at right angle to surface.

3.02 Existing Utilities

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.

- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to OWNER.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to OWNER.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.03 Selective Demolition for Alterations

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Engineer before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
 - 4. When general items are noted for demolition, it is assumed that appurtenances and incidental items associated with the general item should also be demolished and removed.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction where required.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage. Prevent freezing temperatures from occurring. Maintain a minimum temperature of 40 degrees Fahrenheit in all areas where are being used for plant operations or higher temperature if necessary to operate remaining equipment.
- D. 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.

- E. 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.
 - 5. 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. 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.
 - 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. 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 and to maintain the integrity of the grounding systems.
 - 10. Conduits and wires shall be abandoned or removed where shown. 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. Conduits shall be suitably 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.
- F. 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.
- G. 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 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 CONTRACTOR's expense and these excess removals shall be reconstructed to the satisfaction of ENGINEER with no additional compensation to 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 wall be neatly repaired so as to leave only finished edges and surface exposed.

3.04 Debris and Waste Removal

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain OWNER's property, remove demolished materials from Project site and legally dispose of them in an approved landfill.
- B. Do not allow demolished materials to accumulate on-site.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- E. Leave site in clean condition, ready for subsequent work.
- F. Clean up spillage and wind-blown debris from public and private lands.

3.05 Disposal of Tank Contents

- A. CONTRACTOR shall remove and dispose of the contents of tanks, wells, etc. as required to perform the Work.
- B. Liquid in tanks may be returned to the treatment plant process stream with written approval of OWNER.
- C. Provide written certification to OWNER that disposal of tank contents is in accordance with applicable state and federal regulations.

3.06 Cleaning

- A. CONTRACTOR shall clean existing surfaces as required to perform the Work including tanks, wells, channels, floors, walls, etc.
- B. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before demolition operations began.

3.07 Salvage Schedule

A. Existing Items to Be Removed and Salvaged:

1. No existing items will be salvaged to OWNER. CONTRACTOR retains ownership and responsibility for all items shown to be removed.

End of Section

Section 02 8000 Hazardous Material Abatement Procedures

Part 1 General

1.01 General

- A. This property has been identified as having contamination that is associated with previous site activities. Analytical testing completed at the property has identified the presence of volatile organic compounds (VOCs) in the soil above Michigan Department of Environment, Great Lakes and Energy (EGLE) Generic Residential cleanup criteria. See Exhibit A and the Contractor Disclosure Statement for details regarding the onsite subsurface contamination.
- B. In addition to the subsurface contamination, hazardous materials have been identified on/within the subject buildings and are to be legally removed from the job site in order to complete the Work as described in the Proposal and Contract. The removal of asbestos containing materials (ACM) is required.
- C. CONTRACTOR shall contact the Air Quality Division of EGLE, and the Michigan Department of Energy, Labor, and Economic Growth (MDLEG) Asbestos Program, for a permit and furnish all training, labor, materials, services, insurance, and equipment necessary to carry out the removal of ACM from the property. In addition, hazardous materials, as identified in Exhibit A or encountered on the job site, are to be removed for disposal, in accordance with State and Federal Hazardous Waste Codes.
- D. Site Identification: Number and signature must be obtained prior to transportation and disposal of hazardous substances.
- E. Manifests shall be in accordance with the requirements of all the applicable federal, state and local regulations. Manifests shall be signed by OWNER or OWNER's Representative.
- F. The Waste and Hazardous Materials Division of the EGLE regulates waste disposal (air, water, land and liquid industrial) and carries out the requirements of the Federal Environmental Protection Agency (EPA). For general information and/or a copy of the latest regulations and publications contact EGLE.
- G. The Michigan Occupational Safety and Health Administration (MIOSHA) provides protection and regulations for the safety and health of workers. The Michigan Department of Labor and Economic Growth provides for the safety of workers.
- H. CONTRACTOR shall post any applicable State and/or Federal government regulations at the job site in a prominent location.
- I. CONTRACTOR shall be responsible for training their workers in safe work practices and in proper removal methods when coming in contact with hazardous materials/chemicals.

1.02 Applicable Regulations

A. RCRA, 1976 - Resource Conservation and Recovery Act: This federal statute regulates generation, transportation, treatment, storage or disposal of hazardous wastes nationally.

- B. Act 64, 1979 Michigan's Hazardous Waste Management Act: This statute regulates generation, transportation, treatment, storage and disposal of hazardous wastes in Michigan.
- C. Act 136, 1969 Liquid Industrial Waste Act: This statute regulates the transportation of liquid industrial wastes in Michigan. This includes non-hazardous liquids and hazardous liquids which are not subject to management under RCRA or Act 64.
- D. Act 60, 1976 PCB Act: This statute regulates the generation, transportation, storage and disposal of PCB wastes in Michigan.
- E. Federal, State and local laws and regulations may apply to the storage, handling and disposal of hazardous materials and wastes. The list below includes the regulations which are most frequently encountered.

| Торіс | Agency |
|---|---|
| Small quantity hazardous waste management, including hazardous waste stored in tanks | Waste and Hazardous Materials Division, EGLE |
| Liquid industrial waste disposal (hazardous and nonhazardous) | Waste and Hazardous Materials Division, EGLE |
| Discharges to surface water such as through a drain pipe or wastewater discharge | Water Bureau, EGLELocal municipality or agency having jurisdiction |
| Discharges to groundwater, including septic systems | Water Bureau, EGLE |
| Material storage permits | Water Bureau, EGLE |
| Pollution Incident Prevention Plans (PIPP Plans) | Water Bureau, EGLELocal municipality or agency having jurisdiction |
| Hazard Communication Standards (for chemicals in the workplace) | Occupational Health Division, MichiganDepartment of Community Health |

1.03 Disposal

- A. To use an offsite waste disposal facility, CONTRACTOR must use the Uniform Hazardous Waste Manifest (shipping paper). Manifests must be approved by OWNER and copies must be provided to OWNER.
- B. Hazardous waste may not be disposed of in sanitary landfills used for solid waste. Contractor is responsible for following hazardous, non-hazardous, liquid, and solid waste disposal requirements.

Part 2 Products (Not Used)

Part 3 Execution (Not Used)

Section 02 8100 Transportation and Disposal of Hazardous Materials

Part 1 General

1.01 Scope of Work

A. CONTRACTOR shall insure that all vehicles entering and leaving the site comply with safety requirements and licensing requirements of the local, state and federal regulations, prepare vehicles to prevent spillage or contamination, inspect vehicles before leaving the site, transport equipment to and from the site, transport liquids, sludge and other hazardous or non-hazardous materials from the site to an approved facility.

1.02 Submittals

- A. Submit the names of the disposal facilities to ENGINEER for review and comment at least a week before the disposal operation is conducted.
- B. Submit the transportation routes to the selected solid and liquid disposal facilities to ENVIRONMENTAL ENGINEER for review and comment.
- C. Submit to ENGINEER for review and comment, a Spill Contingency Plan for transportation of solids and liquid. The Plan shall address all the potential hazards, necessary actions to follow in case of spills and emergency phone numbers enroute.
- D. Submit copies of all manifests and bill of lading to ENGINEER.
- E. If necessary, submit a plan to decontaminate the vehicle wheels. These procedures could be identified in the overall decontamination plan.

1.03 **Project Record Documentation**

- A. Record weight, volume and character of material disposed.
- B. Provide documentation that measuring devices used, are certified by the appropriate state inspection agency.
- C. CONTRACTOR shall provide to ENGINEER written documentation and records verifying receipt and the quantity received of each load at the disposal facility and verification of proper disposal. Copies of the actual receipt must be provided.
- D. CONTRACTOR shall prepare and maintain accurate manifests or bill of lading for each batch of the waste materials being transported and disposed of. CONTRACTOR is responsible for obtaining OWNER's signatures on manifests for transportation and disposal purposes.
- E. Materials shall be sampled and analyzed in accordance with the disposal requirements as directed by ENGINEER. Testing parameters shall be determined based on the potential for presence of the respective contaminants.

Part 2 Products

2.01 Equipment

A. CONTRACTOR shall provide equipment, personnel and facilities necessary to handle and load materials for transport.

Part 3 Execution

3.01 General

A. Transportation and disposal of all hazardous materials shall comply with federal, state and local regulations.

3.02 Loading and Hauling

- A. Inspect haul vehicles for soil adhesion to wheels and under carriage. Soils shall be removed and properly handled by CONTRACTOR before leaving site. Decontamination procedures shall be carried out at the decontamination zone.
- B. At a minimum, provide wheel wash down using high pressure water and steam. Rinse waters are to be collected for temporary storage prior to disposal. CONTRACTOR will sample collected rinse waters to ensure proper disposal. CONTRACTOR shall be responsible for the disposal and any associated testing.
- C. No transport vehicles shall be allowed to leave the site which are leaking or spilling materials.
- D. Transport vehicles shall be in strict conformance with all the applicable federal, state and local laws.
- E. CONTRACTOR shall keep accurate records for the following information:
 - 1. Type and quantity of materials and liquids removed from the site, and analytical testing results.
 - 2. ENGINEER approval is required before any liquid or material leaves the site.
- F. CONTRACTOR shall provide ENGINEER with copies of the above records, permits required, manifests, waste hauling permits, and necessary affidavit regarding the waste materials, including liquid disposal.
- G. Transport vehicles shall be cleaned before filling with waste material.
- H. Prior to transportation, established pre-transportation requirements shall be met.
- I. Waste shall be transported by a certified waste hauler in approved containers.

3.03 Disposal

 A. For hazardous or non-hazardous contaminated wastes CONTRACTOR shall utilize a State of Michigan approved manifest, (such as the uniform hazardous waste manifest form (8700-22)) so that the waste can be tracked from generation to ultimate disposal.

- 1. Manifest shall comply with all of the provisions of the transportation and disposal regulations.
- 2. Transporters must sign the appropriate portions of the manifest and must comply with all of the provisions established in the applicable regulations.
- 3. Contaminated waste manifests must be signed by OWNER.
- B. Hazardous and non-hazardous materials shall be disposed of at an approved licensed disposal facility.
- C. Arrangements for disposal shall be performed by CONTRACTOR.
- D. Disposal of any material at a non-licensed facility or at private property is strictly prohibited under this contract. Written approval from ENGINEER, ENGINEER designated representative, and OWNER shall be necessary prior to any deviation from this requirement.

3.04 Spills

- A. CONTRACTOR is responsible for cleaning up all the leaks, spills from containers and other items related to the project that occur on site or off site during the time of the contact, whether due to CONTRACTOR's negligence or not.
- B. Immediate containment actions shall be taken as necessary to minimize the effect of any spill or leak. CONTRACTOR shall notify the ENGINEER and appropriate governmental authorities of the incident.
- C. Cleanup shall be in accordance with applicable Federal, State, and local laws and regulations at no additional cost to OWNER.

End of Section

Division 03 Concrete

Section 03 1100 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 1500: Concrete Accessories
- B. Section 03 2000: Concrete Reinforcing
- C. Section 03 3000: Cast-In-Place Concrete

1.03 Design Standards

- A. Formwork shall be designed for the loads, lateral pressure, and allowable stresses outlined in "Recommended Practice for Concrete Formwork" ACI 347 and for design considerations, wind loads, allowable stresses and other applicable requirements of the local building code. Design and construction of the formwork shall be the responsibility of CONTRACTOR.
- B. 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 other forces resulting from the movement of the forms.
- C. 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. A
- 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 347, except as modified below:
 - 1. Variation from plumb in lines and surfaces of piers, walls, or columns:
 - a. In any ten (10) feet (3 m) of length: 1/4 inch (5 mm)
 - b. Maximum for entire length: 1-inch (25 mm)
 - 2. Variation from the level or from the grades:
 - a. In any ten (10) feet (3 m) of length: 1/4 inch (5 mm)
 - b. Maximum for entire length: 3/4 inch (20 mm)
 - 3. Variation of distance between walls, columns and beams:
 - a. In any ten (10) feet (3 m) of distance: 1/4 inch (5 mm)
 - b. Maximum for entire distance: 1-inch (25 mm)

- 4. Variation of the linear lines from established position as indicated on the Plans:
 - a. In any 20 feet (6 m) of length: 1/2 inch (10 mm)
 - b. Maximum for entire length: 1-inch (25 mm)
- 5. Variation in sizes and locations of sleeves, floor openings, and wall openings:
 - a. Minus: 1/4 inch (5 mm)
 - b. Plus: 1/2 inch (10 mm)
- 6. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls:
 - a. Minus: 1/4 inch (5 mm)
 - b. Plus: 1/2 inch (10 mm)
- 7. Variations of footing dimensions from plan dimensions:
 - a. Minus: 1/2 inch (10 mm)
 - b. Plus: 2 inches (50 mm)
- 8. Thickness ± 5%, up to maximum of 1 inch (25 mm)

1.05 Reference Standards

- A. ACI American Concrete Institute
- B. ASTM ASTM International

1.06 Submittals

- A. Submit manufacturer's literature for form coating.
- B. Submit formwork layout plans, design data and procedures if requested by 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 2000, Concrete Reinforcing; Section 03 1500, Concrete Accessories; and Section 03 3000, Cast-In-Place Concrete.

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 (25 mm) 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 (25 mm) back from concrete face.

2.04 Forms - General

A. Use forms that conform to ACI 347. Fabricate with facing materials that produce the specified tolerance requirements of Article 1.04 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 of Article 1.04 of this Section. 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 (25 mm) 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" x 3/4" 45° chamfers (20 mm x 20 mm x 45 degree), 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 superimposed dead, temporary construction, and live loads.
- B. When forms or shoring are removed, there shall be no excessive deflection or distortion of the concrete.
- C. 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.
- D. Form removal shall not impair the safety and serviceability of the structure or concrete members.
- E. 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. Cylinder strength shall be based on test specimens cured in the field, as described in ASTM C31, 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 3000, Cast In Place Concrete.
- F. 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 ENGINEER in order to facilitate effective repair of voids or broken corners before the surface has dried.

G. Forms and shoring in the formwork shall not be removed without the approval of ENGINEER. 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°F (10°C). The times may be increased or decreased as directed by ENGINEER, dependent on air temperatures, cement type, concrete additives or other conditions of the Work in accordance with ACI 347.

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 ENGINEER's review.
- B. During reshoring, no construction loads shall be permitted on the new construction.
- C. 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 1500 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 1100: Concrete Forming
- B. Section 03 2000: Concrete Reinforcing
- C. Section 03 3000: Cast-In-Place Concrete

1.03 Reference Standards

- A. ASTM American Society for Testing Materials
- B. CRD U.S. Army Corps of Engineers Handbook for Concrete and Cement Specifications

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 ENGINEER.

1.05 Environmental Requirements

A. Environmental requirements relative to temperature for placing joint sealants are specified in Article 3.04 of this Section.

1.06 Sequencing

A. CONTRACTOR shall sequence installation of miscellaneous embedded items with the Work of Section 03 1100 Concrete Forming; Section 03 2000, Concrete Reinforcing; and Section 03 3000 Cast-In-Place Concrete.

Part 2 Products

2.01 Joint Filler

- A. Preformed Expansion Joint Filler for Concrete (Bituminous Type) ASTM D994.
- 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 D3406.

2.03 Waterstops

- A. PVC waterstops shall conform to CRD-C572 polyvinyl chloride (PVC) or CRD-C513 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 predrilled 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 A 193 Grade B7, ASTM A 194 Grade 2H or ASTM A 563 Grade DH nuts, and ASTM F 436 washers; plated in accordance with ASTM B 633, 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 B 633, 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 B 633, SC1, Type III or Type 304 stainless steel anchor body, washers, nuts and wedges when so indicated on plans.

Part 3 Execution

3.01 Contractor's Verification

A. Inspect the locations and surfaces to receive joint filler, joint sealer, waterstops, 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. 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 ENGINEER.

3.04 Installation of Joint Sealants

A. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40°Fahrenheit (4°Celsius). 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 as 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. sleeves, inserts, anchor bolts, 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 2000 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.

1.02 Related Work Specified Elsewhere

- A. Section 03 1100: Concrete Forming:
- B. Section 03 1500: Concrete Accessories
- C. Section 03 3000: Cast-In-Place Concrete

1.03 Reference Specifications

A. 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.

1.04 Testing Agency

A. Testing agencies shall meet the requirements of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction, ASTM E329.

1.05 Allowable Tolerances

- A. Fabrication:
 - 1. Sheared length: ± 1-inch (25 mm).
 - 2. Depth of truss bars: +0, -1/2 inch (+0, -10 mm).
 - 3. Stirrups, ties, and spirals: $\pm 1/2$ inch (± 10 mm)
 - 4. All other bends: ± 1 -inch (± 25 mm).

B. Placement:

- 1. Concrete cover to form surfaces: $\pm 1/4$ inch (± 5 mm).
- 2. Minimum spacing between bars: -1/4 inch (-5 mm).
- 3. Top bars in slabs and beams:
 - a. Members eight (8) inches (200 mm) deep or less: ± 1/4 inch (5 mm).
 - Members more than eight (8) inches (200 mm) but not over two (2) feet (600 mm) deep: ± 1/2 inch (±10 mm).
 - c. Members more than two (2) feet (600 mm) deep: ± 1-inch (±25 mm).
- 4. Crosswise of members: Spaced evenly within two (2) inches (50 mm) of stated separation.
- 5. Lengthwise of members: ± 2 inches (±50 mm).

6. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 1-bar diameter, with approval from ENGINEER.

1.06 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 ENGINEER.
- B. CONTRACTOR may be required to furnish additional test of reinforcing steel for each 100 tons (90 metric ton) or fraction thereof. Testing for bend, pull, elongation and weight to assure compliance with Specifications shall be in accordance with ASTM A370.

1.07 Reference Standards

- A. ACI American Concrete Institute
- B. ASTM ASTM International
- C. CRSI Concrete Reinforcing Steel Institute

1.08 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.

1.09 Delivery, Storage, and Handling

- A. Deliver reinforcement to Project site in bundles tagged and marked in accordance with "Manual of Standard Practice" of the CRSI.
- 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.

1.10 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, Grade 60.
 - 2. Rail-Steel Deformed and Plain Bars: ASTM A616-96a, Grade 60.

- 3. Axle-Steel Deformed and Plain Bars: ASTM A617-96a, Grade 60.
- 4. Low Alloy Steel Deformed Bars: ASTM A706.
- C. Mats:
 - 1. Fabricated steel bar or rod mats of the clipped type shall conform to ASTM A184.

2.02 Welded Wire Fabric

- A. Welded wire fabric shall be in flat mats only.
- B. Plain:
 - 1. Conform to ASTM A185, 6 x 6 w2.9 x w2.9 unless otherwise indicated on the Plans.
- C. Deformed:
 - 1. Conform to ASTM A496, 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 A82, 16-gage minimum size.
- B. Deformed:
 - 1. Conform to Deformed Steel Wire for Concrete Reinforcement, ASTM A496, 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 (5 mm) 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.
- B. 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.

C. 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 (#10M - #25M) | 6 bar diameters | | | |
| #9, #10, and #11 (#29M - #36M) | 8 bar diameters | | | |
| #14 and #18 (#43M - #57M) | 10 bar diameters | | | |

- D. Bends for stirrups and ties with number 5 (#16M) bar and smaller shall not be less than four bar diameters. For bars larger than No. 5 (#16M), shall be according to the "Minimum Diameter of Bend" table above.
- E. 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 Contractor's 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. The 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 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 (75 mm) 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 (50 mm) 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 (20 mm) for slabs and walls and 1-1/2 inches (40 mm) 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 (40 mm).
- 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 one inch (25 mm) 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 (450 mm). 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 (25 mm), and the bars in the upper layers shall be placed directly above those in the bottom layer.
- H. 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 (50 mm). 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 Detailing Manual 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 (50 mm). The fabric shall extend across supporting beams and walls and to within 4 inches (100 mm) 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 insure its proper position in the slab either by the methods of Article 3.06 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 insure proper placement, templates shall be furnished for all column dowels.
- F. Bars of size 14, 18 or larger (#43M #57M or larger), where size 11 (#36M) 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 size eleven (#36M) may be butt spliced by mechanical devices approved by 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 "Manual of Standard Practice" of the CRSI.

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 ENGINEER prior to placement of concrete.
- B. CONTRACTOR shall avoid displacement of the reinforcing steel during concrete placement.

End of Section

Section 03 3000 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 2200: Unit Prices
- B. Section 03 1100: Concrete Forming
- C. Section 03 1500: Concrete Accessories
- D. Section 03 2000: Concrete Reinforcing
- E. Section 04 0511; Mortaring and Grouting
- F. Section 05 1200: Structural Steel Framing
- G. Section 05 5000: Metal Fabrications
- H. Section 07 1000: Dampproofing and Waterproofing
- I. Section 31 2319: Dewatering

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. ACI American Concrete Institute
 - 2. ASTM ASTM International
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

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.

1.05 Testing Agency

A. Inspections and tests required by this Section shall be performed by organizations acceptable to ENGINEER.

1.06 Allowable Tolerances

A. See Section 03 1100, Concrete Forming, 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 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 an 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 | <u></u> 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 (500 metric ton) |
|----|------------------|------------------------------|
| 2. | Fine Aggregate | 2,000 Tons (1800 metric ton) |
| 3. | Coarse Aggregate | 2,000 Tons (1800 metric ton) |

D. Use same brand cement for any given structure produced by a single mill unless otherwise provided by authorization of 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 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 ENGINEER with a written request for approval. No concrete shall be placed until CONTRACTOR has received such approval in writing. Each mixture report shall include:
 - 1. Slump on which design is based.
 - 2. Total gallons of water per cubic yard (l/m^3) .
 - 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, 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.
- D. Submit manufacturer's literature of abrasive wear resistant floor finish and of chemical curing compound for review by ENGINEER.
- E. Submit a sample concrete delivery ticket for review by ENGINEER.
- F. 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.
- G. Submit reports of the sampling and testing of slump, air content and strength performed.
- H. 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 304 and as specified below.
- B. When permission is given to store cement in the open, a floor at least six (6) inches (150 mm) 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 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 305 for hot weather concreting, and ACI 306 for cold weather concreting. Specific temperature requirements are contained in Article 2.10 of this Section for mixing and Article 3.13 of this Section for placing.

Part 2 Products

2.01 Materials - General

- A. 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 CONTRACTOR.
- C. Testing and inspection required due to substitution or change of materials requested by CONTRACTOR shall be at CONTRACTOR's expense.

2.02 Cement

- A. Cement shall be the type as indicated on the Plans or as specified.
- B. Type I and IA, conforming to ASTM C150, air-entraining Portland cement when special properties are not specified.
- C. Type III and IIIA, conforming to ASTM C150, air-entraining Portland cement for use when high-early strength is specified.
- D. Type IS and IS-A, conforming to ASTM C595, air-entraining Portland blast-furnace slag cement for use in general concrete construction.
- E. Type IP and IP-A, conforming to ASTM C595, 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 eight (8) inches (200 mm) or less in thickness and Class 6AA for other construction.
- C. Gravel shall consist of hard, clean, durable particles of rock or pebbles and shall be free from lumps of clay.
- D. 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.

- E. 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."
- F. Fine aggregate shall be sand size 2NS, MDOT, Section 902.09.
- G. 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.
- H. 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.
 - 2. Pozzolan and Fly Ash, conforming to ASTM C618, Class C or F.
 - 3. Water reducing, conforming to ASTM C494.
 - 4. Retarder, conforming to ASTM C494.
 - 5. Plasticizer, conforming to ASTM C494.
 - 6. Ground granulated blast furnace slag conforming to ASTM C989, 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 1500, Concrete Accessories.

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, and water with admixtures if required. Admixtures shall not be used without ENGINEER's review. The mixture, combined in proportions, shall meet the requirements of MDOT, Specification Section 701, and ACI 211.1.
- B. 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 65° to 75°F (18° to 24°C). The desired strength of the concrete shall be shown on either the Plans or in the Specifications.

C. 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, Grade 3.5, unless otherwise shown on the plans.

| | | Min Cement Content | | | Min. | Min. Madulua of | | |
|-------------------|---------------------|-----------------------|---------------------|-----------------------|-------------------|-------------------------------------|------------------------------------|-------|
| Concrete Grade | Coarse Aggregate | Type of Cement | lbs/yd ³ | Sacks/yd ³ | kg/m ³ | Strength at 28 Days (PSI/MPa) | Rupture at 28 Days (PSI/MPa) | % Air |
| 4.5 | 6AA | I, IA, IS, IS-A | 658 | 7.0 | 390 | 4,500 / 31.0 | 725 / 5.0 | 4 - 6 |
| 4.0 | 6AA or 17A | I, IA, IS, IS-A | 611 | 6.5 | 362 | 4,000 / 28.0 | 700 / 4.8 | 4 - 6 |
| 3.5 | 6AA or 17A | IS, IS-A, IP, IP-A | 564 | 6.0 | 335 | 3,500 / 24.0 | 650 / 4.5 | 4 - 6 |

Table 1 - Concrete Mixtures

Notes:

1. Maximum water cement ration shall be 0.45

2. Structural concrete for walls and slabs shall be placed with a slump of four (4) inches (100 mm) 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. Fly ash may be substituted for cement on a pound for pound basis up to a maximum of 15% fly ash and 85% cement

- D. Aggregates shall be proportioned by weight, except for small structures and for incidental Work requiring less than 10 cubic yards (7 m³) of concrete, in which case they may be proportioned by volume when approved by ENGINEER.
- E. Cement in bulk, when permitted, shall be proportioned by weight.
- F. 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 foot or 1 cubic meter.
- G. 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 1 percent in any one 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.
- B. If the air content is found to be less or greater than the specified amount, 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 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 ENGINEER per Article 1.09 of this Section 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 (74°C). It may be required that it be stored at CONTRACTOR's expense until cooled to that temperature.
- B. The temperature limits of aggregates and water entering the mixer shall be as follows:

| Limits of Temperature | | | | | |
|-----------------------|-------------|--------------|--|--|--|
| 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. General:
 - 1. 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 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. 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 one (1) minute for one (1) cubic yard (or cubic meter), with an additional 15 seconds for each additional cubic yard (or cubic meter).

- 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. Concrete at the point of delivery shall have the proper consistency and shall be free from segregation. 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.
- 9. 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. If transit-mix concrete is used, it shall meet all the foregoing requirements specified for central mixed concrete and, in addition, the following:
 - a. 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 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. 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 "Harcol," 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 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 (50 mm) 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, CONTRACTOR shall bridge the subgrade with at least 2,000 psi (13.8 MPa), 3-inch (75 mm) 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 2319, Dewatering, and not until after 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. Use of drop chutes, except at or in the forms, is prohibited.
- B. 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 5 times the nominal maximum size aggregate and the area of the gate opening shall be not less than 2 square feet (0.2 m^2) .
 - 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 (1.5 m³) 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 ENGINEER. Pumping equipment shall be piston or squeeze pressure type. Pipeline shall be rigid steel pipe or heavy duty flexible rubber hose. Inside diameter of the pipe shall be at least 3 times the nominal maximum size coarse aggregate in the concrete mixture to be pumped. Maximum size coarse aggregate shall not be reduced to accommodate the pumps.
- E. Distance to be pumped shall not exceed limits recommended by the pump manufacturer. 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 3feet (1 m) 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 inches (150 mm) 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 (600 mm) 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 (1.8 m) of vertical height. Concrete in walls or columns shall set at least 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. 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 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 to 30 inches (450 to 750 mm) apart, but shall not be used to transport concrete within the forms. CONTRACTOR shall have a standby 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 (5 mm) as measured from a 10-foot (3 m) 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 (5 mm) 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 (10 mm per meter).
- B. 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 OWNER.

3.11 Expansion Joints

- A. Comply with the requirements of Section 03 1500, Concrete Accessories. 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 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. 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 (25 mm), 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 inches (150 mm) 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. General:
 - 1. 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, 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°Fahrenheit (4°Celsius), 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° Fahrenheit (4°Celsius).
 - 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.
 - 6. Heating of the housing shall be done in a manner which will maintain a temperature between 50° and 70° Fahrenheit (10° and 20°Celsius), at all times for at least 5 days after the pour is complete and 12 hours before the pour begins.
 - 7. 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°Fahrenheit (32°Celsius).
 - 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 of water per cubic yard of concrete (5 liters per cubic meter) 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 ENGINEER upon delivery. 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 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. General:
 - 1. Tests shall be made of fresh concrete for each 50 cubic yards (40 m³), or whenever consistency appears to vary. Sampling and testing of slump, air content and strength will be performed at no cost to CONTRACTOR.
 - 2. Composite samples shall be secured in accordance with the Method of Sampling Fresh Concrete, ASTM C172.
- B. Slump Test:
 - 1. Slump Test shall be in accordance with ASTM C143. 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 (25 mm) above the indicated maximum slump shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit.
- C. Air Content:
 - 1. Air content of normal weight concrete will be determined in accordance with Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASTM C231.
- D. Compressive Strength:
 - 1. A set of cylinders for compressive strength tests will consist of four cylinders per each set.
 - 2. Molding and curing specimens from each set shall be in accordance with Method of Making and Curing Concrete Test Specimens in the Field, ASTM C31. Any deviations from the requirements of this Standard shall be recorded in the test report.
 - 3. Testing specimens will be in accordance with Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. One (1) specimen shall be tested at 7 days for information and 2 shall be tested at 28 days for acceptance.

- a. The acceptance test results shall be the average of the strengths of the 2 specimens tested at 28 days. If 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 (3.4 MPa).
- 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 CONTRACTOR.
- B. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by 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 ENGINEER, cores at least two (2) inches (50 mm) in diameter shall be obtained and tested in accordance with Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM C42.
- D. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60° to 80°Fahrenheit (15°-25°Celsius), relative humidity less than 60%) for 7 days before test and shall be tested dry.
- E. 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.
- F. At least 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 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.
- G. 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.
- H. 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, 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, 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 ENGINEER.

3.20 Defective Concrete

- A. If, in the opinion of 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 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 4133 Precast Structural Pretensioned Concrete

Part 1 General

1.01 Scope of Work

A. This Section includes precast and precast prestressed 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 Specified Elsewhere

- A. Section 03 1500: Concrete Accessories
- B. Section 03 2000: Concrete Reinforcing
- C. Section 04 0513: Mortar and Masonry Grout

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 Prestressed Concrete Institute

1.04 Qualifications

- A. Manufacturer shall be a company specializing in providing precast and/or precast prestressed concrete products and services normally associated with the industry for at least five (5) years.
 - 1. When requested by 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 D1.1.

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, prestressed concrete design.
- B. Use in the design, applicable codes, ACI 318, or AASHTO Standard Specifications for Highway Bridges.
- C. 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.

D. Watertight Precast reinforced concrete structures shall be designed in accordance with ASTM C890, for A-16 (HS20) loading and installation conditions.

1.06 Reference Specifications

- A. 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 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 OWNER.
- C. Length: $\pm 1/8$ inch per 10 feet (1 mm per meter), $\pm 1/4$ inch (5 mm) maximum
- D. Cross sectional dimensions:
 - 1. Less than 24 inches (600 mm): ± 1/4 inch, (5 mm)
 - 2. 24 to 36 inches (600 to 900 mm): ± 3/8 inch (9 mm)
 - 3. Over 36 inches (900 mm): ± ½ inch (10 mm)
- E. Thickness: $\pm 1/4$ inch (5 mm)
- F. Position of anchors and inserts: $\pm \frac{1}{2}$ inch (10 mm) of centerline location shown on the Plans.
- G. Horizontal alignment or sweep: 1/4 inch (5 mm) total or 1/8 inch per 10-foot length (1 mm per meter), whichever is greater. Maximum of ½ inch (10 mm) gap between two (2) adjacent members due to sweep.
- H. End squareness: 3/8 inch (9 mm) maximum
- I. Blockouts: $\pm \frac{1}{2}$ inch (10 mm) off centerline locations shown on the Plans.
- J. Out of square: 1/8 inch per six (6) feet (5 mm per 3 m) measured on the diagonal.
- K. Warpage, after installation: 1/8 inch per 6-foot (5 mm per 3 m) length, or 3/8 inch (9 mm), whichever is greater.
- L. Vertical alignment:
 - 1. Bottom edges of members from line established at lower face: $\pm 1/4$ inch (5 mm).
 - 2. 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, Prestressed 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 Article 1.05 of this Section.
- B. Submit erection or production drawings showing:
 - 1. Drawings/ elevations locating and defining material furnished by manufacturer.
 - 2. Sections/details showing connections, cast-in items and relation to the structure.
 - 3. Description of 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/details to indicate quantities and position of steel, anchors, inserts, etc.
 - 8. Lifting and erection inserts.
 - 9. Dimensions and finishes.
 - 10. Prestress for strand and concrete strengths.
 - 11. Estimated cambers.
 - 12. 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 and Handling

A. Perform transportation, site handling, and erection with acceptable equipment, methods, and by qualified personnel.

1.11 Storage

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

1.12 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 2000, Concrete Reinforcing.
- 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 04 0511, Mortaring and Grouting 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 AWS D1.1.

2.09 Caulking

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

2.10 Concrete Mixes

A. Precast, Prestressed:

- 1. 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). The strength at initial prestress or form release shall be no less than 3,500 psi (24 MPa). Use of calcium chloride, chloride ions or other salts is not permitted.
- B. Precast:
 - 1. Shall be the same requirements of precast, prestressed, except the mixture shall produce concrete with the 28-day compressive strength no less than 4,000 psi (27.5 MPa).

2.11 Fabrication and Manufacture

- A. Fabrication and manufacture of precast and/or prestressed 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 prestressed products have been erected. Openings shall be approved by 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. 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. Strands shall be recessed 1-inch (25 mm) and holes grouted. The ends of the member shall receive a smooth finish.
- G. 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 Contractor's Verification

A. Examine the substrates and conditions under which the precast concrete is to be installed and notify CONTRACTOR in writing of conditions detrimental to the proper and timely completion of the Work. B. 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. 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 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 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 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 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 and precast prestressed concrete shall be made by 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

Division 04 Masonry

Section 04 0120.92 Masonry Restoration and Cleaning

Part 1 General

1.01 Section Includes

- A. Masonry restoration of Pump Station Building and cleaning of all the new masonry installed under this project, as specified herein and on the Contract Drawings.
- B. Sandblasting and/or use of job mixed basic acids (non-proprietary cleaning materials) will not be allowed under the Contract.

1.01 Related Sections

- A. Section 04 0513: Mortar and Masonry Grout
- B. Section 04 2000: Unit Masonry
- C. Section 09 9000: Painting and Coating

1.02 System Description

- A. Performance Requirements: Provide masonry restoration products and new masonry construction cleaners which have been manufactured for and are appropriate for use on designated substrates.
- B. Existing surfaces to be cleaned shall include brick, limestone and mortar.
- C. The work under this Section includes the removal of the dirty and heavily carboned masonry at the site. The products shall loosen and dissolve dirt, paint oxidation, carbon buildup and other atmospheric pollutants. Any graffiti present shall also be removed.

1.03 Submittals

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Section 01 3300, Submittal Procedures.
- B. Product Data: Submit product data, manufacturer's product sheet, for specified products.
- C. Program Description:
 - 1. Restoration Program: Submit written program description for restoration process describing materials, methods, equipment, and sequence of operations.
 - 2. Cleaning Program: Submit written program description for cleaning process describing materials, methods, equipment, and sequence of operations.
- D. Quality Assurance Submittals: Submit the following:
 - 1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
 - 2. Warranty: Warranty documents specified herein.

1.04 Quality Assurance

- A. Qualifications:
 - 1. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project. Installer must have specific experience with designated Historical Structures.
 - 2. Certificate: When requested, submit certificate indicating qualification.
 - 3. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.
 - 4. Regulatory Requirements: Comply with all Federal, State and Local Government agency regulations that may apply to the use or application of the products covered under this Section.
- B. Preinstallation Meetings: Conduct preinstallation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements. Comply Section 01 3119, Project Meetings.
- C. Preinstallation Testing: Conduct preinstallation testing as follows: Test a 4'-0" x 4'-0" area prior to beginning full scale cleaning operations to determine dilution rate and compatibility with masonry surfaces.
 - 1. Test each type of surface and each type of stain.
 - 2. Test effect of pressure rinsing on the existing surfaces.
 - 3. Allow 3 to 5 days before evaluating results of test cleaning.
 - 4. Do not conduct testing when freezing weather is expected during any phase of the testing procedure. Masonry surface temperatures should be above 40 degrees Fahrenheit.

1.05 Delivery, Storage & Handling

- A. General: Comply with Section 01 6000, Product Requirements.
- B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.06 **Project Conditions**

A. Environmental Requirements/Conditions: Substrate and ambient air temperature shall be in accordance with manufacturer's requirements.

1.07 Warranty

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty: Submit, for OWNER's acceptance, manufacturer's standard warranty document.
 - 1. Warranty Period: One year commencing on Date of Substantial Completion.

Part 2 Products

2.01 Masonry Restoration & Cleaning

- A. Manufacturer: ProSoCo, Inc.
 - 1. Contact: 3741 Greenway Circle, Lawrence, KS 66046; Telephone: (800) 255-4255, (785) 865-4200, Fax: (785) 830-9797.
- B. Proprietary Product(s)/System(s): Sure Klean® Masonry Restoration and Cleaning Products:
 - 1. Enivro Klean and Sure Klean® Masonry Restoration Cleaners.
 - 2. Paint, Coating & Graffiti Removers.
 - 3. New Construction Cleaning Final Clean-Down of Brick.
 - 4. New Construction Cleaning Final Clean-Down of Architectural and Engineered Concrete Surfaces.

2.02 Product Substitution

- A. Substitutions: Substitutions will be permitted under the terms of Section 01 2513, Substitution Procedures.
- B. Substitution products shall be subject to a side by side comparison testing with the specified products.
- C. After the side by side comparison testing is complete, ENGINEER shall select the product that has performed the best in the test samples and that shall be the product used for the Project.

2.03 Masonry Restoration Materials

- A. Products under this Section shall be coordinated with the products provided under Sections of the Contract Documents as to compatibility and suitability in combination with the restoration products.
- B. Exterior Masonry Restoration Cleaners:
 - 1. Enviro Klean EK Restoration Cleaner. For removing moderate to heavy atmospheric staining from brick.
 - a. Characteristics: Clear amber liquid; 1.060 Specific Gravity; No Flash Point; 5.5 pH; 8.82 lbs. wt./gal..
 - 2. 766 Limestone & Masonry Prewash. Non-acidic gel. for removing heavy soiling from acid-sensitive limestone and other masonry surfaces.
 - a. Characteristics: Semi-gel liquid; 1.274 Specific Gravity; No Flash Point; 13.6 pH (at 1:5 dilution); -20 degrees Fahrenheit (-28.8 degrees Celsius) Freeze Point; 10.6 lbs. wt./gal. (1.270 kg wt./L.).

- 3. Limestone Restorer. For removing light to moderate dirt and mildew from calcium-based surfaces.
 - a. Characteristics: Clear liquid, light amber color; 1.141 Specific Gravity; No Flash Point; 0.1 pH (at 1:6 dilution); -40 degrees Fahrenheit (-40.0 degrees Celsius); 9.49 lbs. wt./gal. (1.137 kg wt./L.).
- 4. Asphalt & Tar Remover For removing asphalt, tar, grease and oil from brick, stone and concrete.
 - a. Characteristics: Clear liquid; 0.961 Specific Gravity; 79 degrees Fahrenheit (26.1 degrees Celsius) Flash Point.
- C. Paint, Coating & Graffiti Removers:
 - 1. Heavy Duty Paint Stripper. For Cutting through multiple layers of paint and heavy graffiti.
 - a. Characteristics: Light brown gel; 1.27 Specific Gravity; Greater than 175 degrees Fahrenheit (79.4 degrees Celsius) Flash Point; 14 pH; 10.6 lbs. wt./gal. (1.270 kg wt./L.).

2.04 Masonry Construction Cleaners

- A. Final Clean-Down of Brick and Unpolished Natural Stone Surfaces:
 - 1. 600 Detergent. For general purpose cleaner for masonry and most concrete surfaces.
 - a. Characteristics: Clear liquid; 1.130 Specific Gravity; 0.1 (at 1:9 dilution) pH; -40 degrees Fahrenheit (-40.0 degrees Celsius) Freeze Point; 9.4 lbs. wt./gal. (1.126 kg wt./L.).
 - 2. 101 Lime Solvent. For cleaner for dark colored brick, colored mortar and concrete surfaces which are not subject to metallic staining.
 - 3. Characteristics: Clear liquid, brown color; 1.121 Specific Gravity; 0.14 (1:9 dilution) pH; -40 degrees Fahrenheit (-40.0 degrees Celsius) Freeze Point; 9.33 lbs. wt./gal. (1.118 kg wt./L.).
- B. Final Clean-Down of Architectural and Engineered Concrete Surfaces:
 - 1. Light Duty Concrete Cleaner. For non-etching cleaner which removes efflorescence, construction staining and atmospheric staining from smooth concrete.
 - a. Characteristics: Clear liquid, light brown color; 1.130 Specific Gravity; No Flash Point; .7 (1:1 dilution) pH; 18 degrees Fahrenheit (-7.79 degrees Celsius) Freeze Point; 9.33 lbs. wt./gal. (1.118 kg wt./L.).
 - 2. Heavy Duty Concrete Cleaner. For removing construction staining from textured concrete. Improves color uniformity and produces a moderate etch.
 - a. Characteristics: Clear liquid, slight amber color; 1.142 Specific Gravity; No Flash Point; 1.1 (at 1:6 dilution) pH; less than 32 degrees Fahrenheit (0.0 degrees Celsius) Freeze Point; 9.50 lbs. wt./gal. (1.138 kg wt./L.).

Part 3 Execution

3.01 Manufacturer's Instructions

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.

3.02 Examination

A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions.

3.03 Preparation

- A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.
- B. Surface Preparation: Clean substrates of substances that interfere with penetration or performance of surface treatments. Test for moisture content and pH level, according to manufacturer's instructions, to ensure surface is prepared and dry to receive surface treatments.
- C. Test Application: In general, the following procedures shall be followed for each system. Modifications may be necessary to suit one of the particular products and these suggested modifications should be pointed out during the shop drawing submittal stage so they can be evaluated and approved.
 - 1. Test each surface for each type of stain.
 - 2. Test to see if pressure rinsing will be effective.
 - 3. Evaluate test area between 3 and 7 days after the conducting the initial tests.
 - 4. Surface temperature of the material to be cleaned must be 40°F and rising.
 - 5. Air temperature should remain above freezing during the evaluation period.
 - 6. Conduct first test with product at full strength.
 - a. If first test is successful, conduct a second test at 2:1 dilution rate.
 - b. If second test is successful, conduct a third test at 3:1 dilution rate.
 - c. Each test shall be conducted on a different area of the same wall for comparison purposes.
 - d. 3:1 is the maximum allowable dilution rate for the products.
 - e. CONTRACTOR can use the highest rate that still cleans effectively in the opinion of ENGINEER.

3.04 Installation

- A. Masonry Restoration and Cleaning Installation:
 - 1. Masonry Cleaning: Cleaning procedures for brick/masonry surfaces shall include the application of 766 Masonry Pre-wash followed by Restoration Cleaner in

strict accordance with the manufacturer's recommendations. This application may be modified as required to improve final results based on the evaluated results of the field testing on the existing masonry.

- 2. Stone Cleaning: Cleaning procedures for stone surfaces shall include the application of Limestone Pre-wash followed by Limestone After-wash in strict accordance with the manufacturer's recommendations. This application may be modified as required to improve final results based on the evaluated results of the field testing on the existing limestone.
- 3. Masonry Repointing: Masonry areas found to be loose and deteriorated shall be re-pointed to meet ENGINEER approval.
- B. Special Techniques: Manufacturer's recommendations shall be followed with regards to the protecting of other materials that will not be cleaned or that could be damaged by contact with the restoration materials. CONTRACTOR shall mask off all non-compatible materials or provide other means of adequate protect. Any damage shall be repaired at CONTRACTOR's expense.
- C. Interface with Other Work: CONTRACTOR shall coordinate his efforts with other Contractors working in the area. This work shall be scheduled to avoid any potential conflicts and minimize inconvenience to OWNER.
- D. Sequence of Operation: The building to be cleaned/restored shall be scheduled with the Plant Superintendent so the plant's operations can continue with a minimum of disruption. CONTRACTOR shall schedule CONTRACOTR's operations to avoid closing any portions of the plant that the operators need access to.

3.05 Cleaning

A. Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to OWNER's acceptance. Remove construction debris from project site and legally dispose of debris.

3.06 Protection

A. Protection: Protect cleaned surfaces and installed surface treatments.

End of Section

Part 1 General

1.01 Section Includes

- A. Mortar and grout for masonry.
- B. Repointing of existing masonry where called for on the Drawings or specified.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 04 2000: Unit Masonry
- C. Section 05 5000: Metal Fabrications
- D. Section 08 08 1213: Custom Steel Frames

1.03 References

- A. TMS 402 Building Code Requirements for Masonry Structures.
- B. TMS 602 Specifications for Masonry Structures.
- C. ASTM C91 Masonry Cement.
- D. ASTM C144 Aggregate for Masonry Mortar.
- E. ASTM C150 Portland Cement.
- F. ASTM C207 Hydrated Lime for Masonry Purposes.
- G. ASTM C270 Mortar for Unit Masonry.
- H. ASTM C387 Packaged, Dry, Combined Materials, for Mortar and Concrete.
- I. ASTM C404 Aggregates for Masonry Grout.
- J. ASTM C476 Grout for Masonry.
- K. ASTM C780 Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- L. ASTM C1019 Method of Sampling and Testing Grout.
- M. ASTM C1072 Method for Measurement of Masonry Flexural Bond Strength.
- N. ASTM E447 Test Methods for Compressive Strength of Masonry Prisms.
- 0. ASTM E518 Test Method for Flexural Bond Strength of Masonry.
- P. IMIAC (International Masonry Industry All-Weather Council) Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Include design mix, indicating the proportion specifications of the mix per ASTM C270.
- C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
- D. Reports: Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270, component mortar materials to requirements of ASTM C270 and test and evaluation reports to ASTM C780.
- E. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C476 and test and evaluation reports to ASTM C1019.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 Quality Assurance

- A. Perform Work in accordance with TMS 402 and TMS 602.
- B. Maintain one copy of each document on site.

1.06 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 Environmental Requirements

- A. Cold Weather Requirements: IMIAC Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees Fahrenheit (32 degrees Celsius) prior to, during, and 48 hours after completion of masonry work.
- C. Environmental requirements shall meet the Michigan Building Code requirements, Section 2104 Construction, for both construction and protection.

Part 2 Products

2.01 Materials

- A. Portland Cement: ASTM C150, Type I, gray-white.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Water: Clean and potable.
- D. For pigmented mortar, use a colored cement formulation as required to produce the color indicated or as selected from manufacturer's standard formulations.

- 1. Pigments shall not exceed 10% of Portland cement by weight for mineral oxides nor 2% for carbon black.
- 2. Pigments shall not exceed 5% of mortar cement or masonry cement by weight for mineral oxides nor 1% for carbon black.
- E. Bagged Masonry Cements.

2.02 Admixtures

- A. No admixtures shall be used without the expressed written approval of ENGINEER.
- B. It is not the intent of ENGINEER to allow the use of admixtures.

2.03 Mortar Mixes

- A. Mortar for Load Bearing Walls and Partitions: ASTM C270, Type S using the Proportion specification.
- B. Mortar for Non-Load Bearing Walls and Partitions: ASTM C270, Type S using the Proportion specification.
- C. Integral Water Repellent: Provide water repellent additive by the same manufacturer for mortar and CMU systems containing integral water repellent admixture
 - 1. Refer to Section 04 2200, Unit Masonry, for additional requirements and coordination.

2.04 Mortar Mixing

- A. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. If water is lost by evaporation, re-temper only within two hours of mixing.
- E. Use mortar within two hours after mixing at temperatures of 90 degrees Fahrenheit (32 degrees Celsius), or two-and-one-half hours at temperatures under 50 degrees Fahrenheit (10 degrees Celsius).

2.05 Grout Mixes

A. Bond Beams, Lintels and other areas that may be called for on the Drawings: 2,000 psi (14 MPa) strength at 28 days; 8-10 inches (200-250 mm) slump; mixed in accordance with ASTM C476, fine grout.

2.06 Grout Mixing

- A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 Fine grout.
- B. Do not use anti-freeze compounds to lower the freezing point of grout.

- A. Test mortar and grout in accordance with Section 01 4500, Quality Control.
- B. Testing of Mortar Mix: In accordance with ASTM C780 for compressive strength, consistency, mortar aggregate ratio, water content, air content, splitting tensile and strength.
- C. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength and slump.

2.08 Repointing Specifications

- A. Deteriorated mortar joints in existing Building masonry, and other areas that may be shown on the Drawings, shall be cleaned out and refilled with fresh mortar.
- B. New mortar installed as part of this work shall match the color of the adjacent mortar for the area being worked on.
- C. Joints shall be considered deteriorated if they are eroded back 1/4-inch or more from the face of the masonry units; mortar has fallen out of the joint; hairline cracks run through the mortar; or the bond between mortar and masonry unit is broken.
 - 1. CONTRACTOR shall refer to section 00 4243 for quantities of mortar joint repointing for the project.
 - 2. This repointing is in addition to specific areas specified or shown on the Drawings to be repaired. ENGINEER shall mark areas to be repointed in field.
 - 3. The repointing and repairs shall be done after new masonry weeps are installed.
- D. Raking the Old Mortar Joints:
 - 1. Mortar joints should be raked out to at least 1/2-inch depth or, if the joint is more than 1/2-inch thick, to a depth as great as the thickness of the mortar joint.
 - 2. If the mortar is still unsound at 1/2-inch, the joint shall be cut deeper.
 - 3. Unsound mortar shall be removed without disturbing the brick.
- E. Mortar may be removed with a hand-held grinder, a small mason's chisel, or a special raking tool.
 - 1. If the grinder is used to rake vertical joints, care shall be taken not to cut the brick in the next course above or below the joint.
 - 2. Before repointing, brush all loose fragments and dust from the joint or flush them out with a stream of water.
- F. Repointing mortar should closely match the existing mortar in strength, hardness, color, and texture.
- G. Test the existing mortar to see what mix proportions were used.
 - 1. Type N mortar may be used if the original mortar cannot be duplicated.

- a. Type N mortar should be made from 1-part Portland cement, 1-part Type S hydrated lime, and 4-1/2 to 6 parts sand.
- 2. The mortar ingredients shall be high quality.
 - a. Portland cement (gray or white) shall meet the requirements of ASTM C 150, Type I or IA.
 - b. Hydrated mason's lime should meet the requirements of ASTM C 207, Type S. Hydraulic quicklime.
 - c. Sand should meet ASTM C 5 and C 144 requirements, respectively.
 - d. Do not use admixtures.
- 3. To compensate for shrinkage, a prehydration process shall be used.
 - a. Mix the dry ingredients with only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball.
 - b. Keep the mortar in this damp condition for 1 to 2 hours and then add the remaining water required.
 - c. Mortar for repointing should be somewhat drier than mortar used to lay masonry units.
 - d. This drier mix is easier to place:
 - e. It does not flow to the bottom of the joint after it has been pushed into the joint with the repointer's trowel.
- 4. To see if the color of the new mortar matches the color of the old mortar, test a sample area in an inconspicuous spot before repointing the entire job.
 - a. Use a garden hose to soak a portion of the wall.
 - b. The color of the new mix should match the darker color of the wetted old mortar.
 - c. Minor adjustments, such as adding or subtracting sand or cement, may be necessary (but they must stay within the limits set by ASTM C 270 for the type of mortar selected).
 - d. A record shall be kept of the exact proportions so the same color can be reproduced in other batches throughout the job.
- 5. Ordinary gray or white mortars can be retempered as needed within the first 2-1/2 hours after they are mixed.
- 6. Colored mortars shall not be retempered.

Part 3

3.01

3.02

Execution

herein.

Mortar:

1.

2.

Examination

Installation

A.

A.

B.

3. Follow color manufacturer's recommendations for re-temper colored mortar to avoid color mis-match."

"Measurement of materials for mortar shall be by volumetric measure and be controlled and accurately maintained. Measurement by "Shovel full" shall not be

Mortar shall be retempered as required to maintain consistency. Dispose offsite of mortar which has begun to stiffen, set or which is over 2-1/2 hours old.

Request inspection of spaces to be grouted by ENGINEER prior to start of work specified

- C. Work grout into masonry cores and cavities to eliminate voids.
- D. Do not install grout in lifts greater than 16 inches (400 mm) (two CMU courses without consolidating grout by rodding.
- E. Do not displace reinforcement while placing grout.

Install mortar in accordance with ASTM C270.

F. Remove excess mortar from grout spaces.

permitted."

3.03 Field Quality Control

- A. Field inspection and testing will be performed in accordance with the Structural Tests and Special Inspections in TMS 602, refer to Table 4.
- B. Test and evaluate mortar in accordance with ASTM C780.
- C. Test and evaluate grout in accordance with ASTM C1019.

End of Section

Section 04 2200 Unit Masonry

Part 1 General

1.01 Section Includes

- A. Face brick
- B. Concrete masonry units (CMU).
- C. Reinforcement, anchorage, and accessories.

1.02 Related Sections

- A. Section 04 0513: Mortar and Masonry Grout
- B. Section 05 5000: Metal Fabrications
- C. Section 07 6000: Flashing and Sheet Metal
- D. Section 07 9200: Joint Sealants
- E. Section 08 1213.53: Custom Steel Frames

1.03 References

- A. TMS 402 Building Code Requirements for Masonry Structures.
- B. TMS 602 Specifications for Masonry Structures.
- C. ASTM A82 Cold-Drawn Steel Wire for Concrete Reinforcement.
- D. ASTM A123 Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.
- E. ASTM A167 Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- F. ASTM A525 Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.
- G. ASTM A580 Stainless and Heat-Resisting Steel Wire.
- H. ASTM A615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- I. ASTM A641 Zinc-Coated (Galvanized) Carbon Steel Wire.
- J. ASTM C62 Building Brick (Solid Masonry Units Made From Clay or Shale).
- K. ASTM C90 Load-Bearing Concrete Masonry Units.
- L. ASTM C129 Non-Load Bearing Concrete Masonry Units.
- M. ASTM C216 Facing Brick (Solid Masonry Units Made From Clay or Shale).
- N. ASTM C652 Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
- 0. IMIAC International Masonry Industry All-Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
- P. UL Fire Resistance Directory.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data for masonry units and fabricated wire reinforcement.
- C. Product Data: Provide data for masonry accessories, cleaning solution, dovetail anchors, flashing, joint filler, masonry mat, weep hole material, etc.
- D. Samples: Submit four samples of masonry units (if requested) to illustrate color, texture and extremes of color range.
- E. Manufacturer's Certificate: Certify that all masonry units covered by this specification meet or exceed all appropriate, referenced ASTM Specification requirements.

1.05 Quality Assurance

- A. Perform Work in accordance with TMS 402 and TMS 602.
- B. Maintain one copy of each document on site.
- C. Environmental requirements shall meet the Michigan Building Code requirements, Section 2104 Construction, for both construction and protection.

1.06 Qualifications

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.07 Mockup

- A. Provide mockup of composite masonry under provisions of Section 01 4500, Quality Control.
- B. Construct a masonry wall into a panel sized 9 feet (3 m) long by 3 feet (1 m) high, which includes mortar and accessories, wall openings, flashings, wall insulation, air barrier, vapor barrier, etc.
- C. Locate as directed by ENGINEER.
- D. Mockup may, at the ENGINEER's discretion, remain as part of the Work.

1.08 Pre-Installation Conference

A. Convene one week prior to commencing work of this sections.

1.09 Delivery, Storage, And Handling

A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.

1.10 Environmental Requirements

- A. Cold Weather Requirements: IMIAC Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees Fahrenheit (32 degrees Celsius) prior to, during, and 48 hours after completion of masonry work.

1.11 Coordination

A. Coordinate the masonry work with rough stone veneer, installation of door frames and window anchors.

Part 2 Products

2.01 Face Brick

- A. Face brick shall be ASTM C216, Type FBX, Grade SW, color shall be Glen Gery Tawny Beige Modular (S32). Color, texture, module and size to match existing. Submit samples for OWNER/ENGINEER review and approval.
 - 1. Substitutions will be allowed but are subject to review and approval by OWNER/ENGINEER.

2.02 Concrete Masonry Units

- A. Masonry block units on the project shall be uniform in color. Units that are specified to receive pigment shall have the color uniform all the way through the unit.
- B. Color for integrally colored units used in the building(s) shall be synthetic iron oxide, dry granulated pigments. Color shall be selected by the Owner from the manufacturers complete color palette.
- C. Concrete Brick Units: ASTM C55, medium weight block units.
- D. Hollow Load Bearing Block Units (CMU): medium weight, ASTM C-90.
- E. Solid Load-Bearing Block Units (CMU): medium weight, ASTM C-90.
- F. Integrally Colored Split Faced Size and Shape: Nominal modular size of 8 x 16 x thickness shown having a split face on one side of masonry block as shown on Drawings. Provide special units for 90 degree corners, bond beams, lintels, and bullnosed corners.
- G. Standard Block Size and Shape: Nominal modular size of 8 x 16 x thickness shown having a smooth face. Provide special units for 90-degree corners, bond beams, lintels, and bullnosed corners.

2.03 Reinforcement and Anchorage

- A. Multiple Wythe Joint Reinforcement: 2 wire ladder type with 1/4" diameter adjustable veneer ties; steel wire, hot dip galvanized to ASTM A153 Class B2 after fabrication, 9 gage (3.7 mm) side rods with 9 gage (3.7 mm) cross ties. Length of adjustable wire ties to be coordinated with drawings.
 - 1. Approved Manufacturers:
 - a. Hohmann & Barnard, Inc., 270-ML
 - b. Wire-Bond, Series 800
 - c. ENGINEER-approved equal

2.04 Mortar and Grout

A. Mortar and Grout: As specified in Section 04 0513, Mortar and Masonry Grout.

2.05 Flashings

- A. Copper/Fabric Flashings at Multiple Wythe Exterior Walls: 3 oz/sq ft (915g/sq m) sheet copper bonded between 2 layers of kraft paper, manufactured by:
 - 1. Hohmann & Barnard C-Kraft Duplex
 - 2. ENGINEER-approved equal
- B. Base Flashing at Single Wythe Exterior Walls:
 - 1. BlockFlash" pan flashing with adjoining bridge, integral weeps (with bug guards) and drainage mats manufactured by Mortar Net Solutions.
 - 2. Install at wall base above grouted core row and above wall opening lintels.
- C. Rubberized-Asphalt Flashing: Manufacturer's standard composite flashing product consisting of a pliable and highly adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of 0.040 inch (1.0 mm).
 - 1. W.R. Grace & Co., Construction Products Division, Perm-A-Barrier Wall Flashing.
 - 2. Hohmann & Barnard, Inc., Textroflash.
 - 3. Williams Products, Inc., Everlastic MF-40.
- D. Asphalt Mastic: Asphalt based cement used as a bonding agent for bonding asphalt coated flashings to all construction surfaces.
 - 1. Hohmann and Barnard "Asphalt Mastic".

2.06 Accessories

- A. Joint Filler (Backer Rod): Refer to Specification Section 07 9200, Joint Sealants.
- B. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- C. Mortar Netting: Mortar net for use in vertical, multiple wythe cavity shall be "The Mortar Net" system with 0.4 inch thick, for nominal 1'-0" walls and 1" thick for nominal 1'-2' walls, 10 inch high nylon mesh material with dovetail shape as manufactured by Mortar Net USA Ltd.
- D. Mortar Mesh: Mortar mesh for use in horizontal joints to prevent mortar or grout from falling through; mesh shall be monofilament screen made from galvanized wire or polypropylene polymer, DUR-O-STOP as manufactured by Dur-O-Wall, Inc., or MGS Mortar/Grout Screen by Hohmann & Barnard.
- E. Weep Hole Vents: Provide CavClear Weep Vents manufactured by CavClear/Archovations, Inc., Hudson WI 54016, (888)436-2620 or approved equal.
 - 1. Non-woven mesh with M notched bottom.
 - 2. Color to match mortar as selected by OWNER.
 - 3. Size: 3/8-inch by 2-1/2-inches high by 3-1/2-inches wide.
- F. Control Joint Filler: 3/8-inch thick, 3-inch wide, closed cell neoprene strip gasket. Use two 3-inch strips at CMU wall, for installed width of 6-inches.
- G. Cleaning Solution:

- 1. Cleaning solution shall be as recommended by the cleaning solution manufacturer from their line of Masonry Cleaning Products.
- 2. Approved manufacturers are Diedrich Technologies or ProSoCo.
- 3. Manufacturer's printed recommendations and cleaning procedures shall be strictly followed.
- 4. Submit Manufacturer's recommendations and procedures as part of the shop drawing submittals.

Part 3 Execution

3.01 Examination

- A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Verify that foundations are within tolerances specified.
 - 2. Verify that reinforcing dowels are properly placed.
 - 3. Verify that the structural steel frame and miscellaneous metal work is complete, plumb, secured and properly located to allow masonry work to be installed as detailed and with adequate clearances.
- B. Foundation and steel frame discrepancies:
 - 1. Notify ENGINEER and OWNER's Representative in writing of discrepancies.
 - 2. Foundation and/or steel frame discrepancies: Do not proceed with masonry work until conditions have been corrected.
 - 3. Foundation discrepancies affecting the masonry work shall be resolved by Foundation Contractor, the Masonry Contractor and OWNER Representative without Owner's extra cost.
 - 4. Steel Frame discrepancies affecting the masonry work shall be resolved by the Steel Frame Contractor, the Masonry Contractor, and OWNER's Representative without any additional cost to OWNER.
- C. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.
- D. Verify that field conditions are acceptable and are ready to receive work. ENGINEER shall be notified of any conditions not suitable to receive the Unit Masonry work.
- E. Verify items provided by other sections of work are properly sized and located.
- F. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 Preparation

- A. Direct and coordinate placement of metal anchors supplied to other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building Structure Provides Permanent Bracing.

3.03 Coursing

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Lay out work carefully in advance to make joints, both horizontal and vertical, fit the openings with a minimum of cutting.
 - 1. Provide joints of uniform width. Form corners as true 90-degree angles unless otherwise shown.
 - 2. Exposed units shall be free from chips on faces and exposed edges, and from broken corners.
- C. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- D. Face Brick Units:
 - 1. Bond: Running (Stack Bond only as noted).
 - 2. Lay up brick on a bed joint in a beveled peak away from the cavity to minimize mortar protrusions into the cavity.
 - 3. Do not furrow bed joints, butter ends of stretchers, and sides of headers if used, with mortar before laying. Fill vertical joints with mortar.
 - 4. Construct head joints by pushing units tightly into mortar against adjoining unit.
 - 5. Lay bricks with joints of uniform width, approximately 3/8-inch, with horizontal joints level and with vertical joints plumb.
 - 6. Tool exterior joints concave.
 - 7. Tool joints of interior brick walls concave.
 - 8. Provide special brickwork as required to complete the work.
 - a. Return brick into reveals at openings in walls.
 - b. Lay brick so that finished brick surface only is exposed in the finished work.
 - c. Where corner edges or cut brick are exposed, cut the brick with an abrasive saw, and provide cut brick with sharp, straight, true edges.
 - d. Refer to drawings for locations, elevations, and details of patterns of brick.
- E. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8-inches (200 mm).
 - 3. Mortar Joints:
 - a. Lay up block units on a bed joint in a beveled peak away from the cavity to minimize mortar protrusions into the cavity.

- b. Do not furrow bed joints, butter ends of stretchers, and sides of headers if used, with mortar before laying.
- c. Fill vertical joints with mortar. Construct head joints by pushing units tightly into mortar against adjoining unit.
- d. Lay units with joints of uniform width, approximately 3/8-inch, with horizontal joints level and with vertical joints plumb.
- e. Tool exterior joints concave.
- f. Tool joints of interior block walls concave.
- F. CMU used in conjunction with the ACMU shall have a similar surface texture and be integrally colored to match the ACMU color for the specific area.
- G. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- H. Door jambs and other exposed corners shall be manufactured bullnosed block. Unless otherwise shown on the Drawings, grinding block in the field shall not be acceptable.

3.04 Placing and Bonding

- A. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Cores to be grouted solid shall have the CMU cross webs set in a mortar bed to prevent the grout from flowing into the adjacent cells.
- C. Provide expansion joints in masonry work.
 - 1. Between top of masonry walls or partitions and underside of steel or concrete beams, metal deck, or concrete slabs; at ends of masonry walls or partitions abutting other construction, or other masonry walls or partitions except at tooth-bonded intersections; and elsewhere as shown; by packing the space with Expansion Filler.
 - 2. Provide the last course in such walls or partitions of solid units terminating to provide 3/8-inch space minimum.
- D. Install vertical mortar netting in nominal cavity between units if multiple wythes are used.
- E. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
- F. Remove excess mortar as work progresses.
- G. For the finished masonry walls that will not be painted:
 - 1. Avoid use of excess mortar.
 - 2. Remove excess mortar as work progresses.
 - 3. Immediately clean mortar from the face of the CMU or ACMU wall units.
 - 4. Precautions shall be taken to avoid staining of the finished surface of the masonry units.

- H. Walls that are shown on the Drawings to receive fluted, burnished or split faced block shall be made up of multiple wythes.
 - 1. Joints between the multiple wythes shall receive a full bed of mortar.
 - 2. The use of single wythes in the wall may be approved based on specific requests by the mason prior to the start of work.
- I. If integrally colored masonry block is used on the project, CONTRACTOR shall base work on multiple colors being utilized on the project.
 - 1. Adjacent room that have different color block will require a multi-wythe wall construction to accommodate this condition.
 - 2. Colors for the project will be selected by OWNER from the block manufacturer's palette of all colors available for the specific block during the shop drawing approval procedure.
 - 3. Change of color of the masonry block shall occur at door and window frames separating the areas.
- J. Interlock intersections and external corners. The intersection of all walls shall be toothed together with the intersecting wall.
- K. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- L. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- M. Broken or chipped masonry units will not be allowed. Care shall be taken during handling and installation to prevent any damage to the face and edges of all block units.
- N. Where built-in terms are to be embedded in cores of hollow masonry units, place a grout retainer in the in joint below and rod mortar or grout into core.
- 0. Fill cores in hollow concrete masonry units with grout 24-inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- P. Provide mortar beds on top of walls where walls support steel framing or precast concrete members. Build up mortar beds to provide elevations required to receive such members. Trowel surface of mortar beds true and level.
- Q. Fill the spaces between metal frames and masonry with grout.
- R. Use cores filled with mortar or provide solid units for anchorage in locations where handrails, plumbing fixtures, utility cabinets and similar items are attached.
- S. Construct masonry walls and partitions of proper thickness to receive pipe, ducts, conduit and similar core-run items, whether or not so dimensioned. If room sizes or critical space requirements are affected by the need for larger units, obtain approval from OWNER's Representative before proceeding.
- T. Masonry work that shows evidence of having been frozen shall be removed and replaced with new materials.
- U. Masonry work shall never be placed on snow- or ice-covered surfaces. The surfaces shall be cleaned and dried prior to proceeding with the new masonry work.

- V. Wet or frozen masonry units shall not be used until they are allowed dry.
- W. Masonry walls shall be covered at night or whenever work is not underway to prevent moisture entry into the wall.
 - 1. Finished walls shall have the tops of exposed walls covered to prevent moisture entry into the wall.
 - 2. Wall covering shall be waterproof tarps, reinforced polyethylene sheets or other approved waterproof barrier, anchored in place so they will not be displaced by the weather.

3.05 Weeps

- A. Place weep vents in head joints of exterior wythes of cavity wall located immediately above ledge and flashing, spaced 24-inches on center, unless otherwise shown.
- B. Leave the side of the masonry units forming the weep vent space unbuttered and clear of mortar. Install with the notched side down.
- C. Slide vent material into place once the two masonry units forming the weep are in place.

3.06 Reinforcement and Anchorage – Single and Multiple Wythe Masonry

- A. Install horizontal joint reinforcement 16-inches (400 mm) on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below all sills, lintels and other openings. Extend each side of opening from control joint to control joint.
- C. Place joint reinforcement continuous in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6-inches (150 mm).
- E. Install prefabricated corners and tees.
- F. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch (13 mm) of dimensioned position.
- G. Provide reinforced walls or piers in locations shown. Install vertical reinforcing in block cores, of sizes and at spacings shown.
 - 1. Loop and wire-tie to dowels at bottom.
 - 2. If splicing of reinforcing is required, lap joints and wire-tie as required by the codes.
 - 3. After mortar has set, fill cores containing reinforcing with grout.
 - 4. If only segments of a wall are reinforced, provide setting mortar on cross-webs adjacent to segment, during laying, to contain the grout in the reinforced cores.

3.07 Masonry Flashings

- A. Extend flashings horizontally at foundation walls, above ledge or shelf angles and lintels, under parapet caps, and at bottom of walls.
- B. Turn flashing up minimum 8-inches (200 mm) and bed into mortar joint of masonry, seal to concrete, seal to steel or other back-up.

- C. For single wythe masonry unit walls provide a double wythe to allow embedment of the flashing between the two wythes.
 - 1. The double wythe only needs to be 1 course high.
 - 2. General installation shall follow requirements for multi-wythe walls as shown on the Drawings.
- D. Lap end joints minimum 6-inches (150 mm) and seal watertight.
- E. Turn flashing, fold, and seal at corners, bends, and interruptions.

3.08 Lintels and Bond Beams

- A. Install loose steel where shown on the Drawings.
- B. Provide concrete masonry lintel units matching the stretcher units in size and texture for lintels at locations with openings greater than 24-inches.
 - 1. Place reinforcing bars as shown and fill void with grout.
 - 2. Construct lintel with a minimum of 8-inches of bearing at each end.
 - 3. Where lintel is exposed in final construction, match the bond pattern used in the wall.
 - 4. Cure field fabricated lintels before handling and installing or temporarily support built-in-place lintels until cured.
- C. Provide concrete masonry bond beam units or other methods of grout confinement for bond beams.
 - 1. Place reinforcing bars as shown and fill void with grout.
 - 2. For continuous bond beams, lap reinforcing bars 12-inches minimum and provide bars around corners.
 - 3. Tie bond beams to structural members as shown.
- D. Install reinforced unit masonry lintels over openings, where steel or precast concrete lintels are not scheduled.

3.09 Grouted Components

- A. Place horizontal mortar mesh over cores below grouted course(s).
- B. Reinforce bond beam with 4, No. 5 bars, 1 inch from top or bottom web unless noted otherwise on the Drawings.
- C. Lap splices minimum 24 bar diameters.
- D. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch (13 mm) of dimensioned position.
- E. Place and consolidate grout fill without displacing reinforcing.
- F. At bearing locations, fill masonry cores with grout for a minimum 12-inches (300 mm) either side of opening.

- G. At vertical reinforcing steel locations, grout cores solid as shown on the Drawings.
 - 1. Insulation inserts shall remain in the grouted cores.
 - 2. Insulation inserts shall be tight to the interior surface of the block prior to the grout placement.

3.10 Control and Expansion Joints

- A. Do not continue horizontal joint reinforcement through control and expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as shown on the Drawings and in accordance with Section 07 9200 for sealant performance.
- D. Construct typical control joints and expansion joints by breaking the running bond in the wall with a continuous thru-wall vertical joint 3/8-inch-wide and provide 1/2-inch-deep sealant space.
 - 1. In concrete masonry unit work, construct the control joint by laying up the block with the half core end at the joint; as concrete masonry units are laid up, line one side of the joint with 1 ply of Bond Breaker Strip and fill the core and web space formed at the joint with mortar, packed in place, to form a keyed joint which will withstand lateral pressure.
 - 2. In brick-concrete masonry unit work, or brickwork, fill the joint with Flexible Joint Filler Strip, recessing the strip to provide the 1/2-inch-deep sealant space.
- E. Isolation Joints
 - 1. Provide isolation joints wherever masonry encloses a steel column and elsewhere as shown.
 - 2. Construct joints by separating the masonry from the steel with Isolation Gaskets. Do not compress the Isolation Gasket.

3.11 Built-In Work

- A. As work progresses, install built-in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items to be built-in the work and furnished by other sections.
- B. Install built-in items plumb level and true to line.
- C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with mortar. Fill adjacent masonry cores with mortar minimum 12-inches (300 mm) from framed openings.
- D. Do not build in organic materials subject to deterioration.

3.12 Tolerances

- A. Maximum Variation from Alignment of Columns or Pilasters: 1/4-inch.
- B. Maximum Variation from Unit to Adjacent Unit: 1/32-inch.
- C. Maximum Variation from Plane of Wall: 1/4-inch in 10 ft and 1/2-inch in 20 ft or more.

- D. Maximum Variation from Plumb: 1/4-inch per story non-cumulative; 1/2-inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8-inch in 3 ft and 1/4-inch in 10 ft; 1/2-inch in 30 ft.
- F. Maximum Variation of Joint Thickness: 1/8-inch in 3 ft.
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4-inch.
- H. Maximum Variation of Head Joint Alignment, Every Second Course: 1/8-inch in 2 ft and 1/4-inch in 8 ft.

3.13 Cutting and Fitting

- A. Cut and fit for chases, pipes, conduit, sleeves, grounds, etc. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 Field Quality Control

- A. Field inspection and testing will be performed under provisions of Section 01 4500.
- B. Field Inspections / Quality Assurance.
 - 1. Special masonry inspections shall be required for engineered masonry that is part of non-essential buildings as defined MBC Section 1705.4.
 - a. Refer to Structural drawings for additional requirements and criteria.
 - b. Seismic resistance testing shall be in accordance with MBC Section 1705.13.

3.15 Cleaning

- A. Clean work under provisions of Section 01 7700, Closeout Procedures.
- B. Clean exposed surfaces of masonry thoroughly to remove mortar, dirt, paint spots, stains, efflorescence and defacements.
 - 1. Protect exposed adjacent materials during installation and cleaning operations.
 - 2. Remove mortar droppings from aluminum and other metal surfaces daily.
 - 3. Do not use sand blast, or other materials or methods that will stain, discolor, or damage the masonry surfaces in any way.
- C. Point up joints full and even and to match tooling used on wall.
 - 1. Cut out and point up defective joints during or before cleaning.
 - 2. Clean out and provide proper-depth recesses for calking and sealing work.
 - 3. Mortar shall match adjacent installations in color and texture.
- D. Brush clean concrete masonry units as the work progresses.
 - 1. Allow mortar droppings on such surfaces to dry and then remove by trowel, block-rubbing and brushing.

- E. Protect surfaces that could be harmed by cleaning operations.
- F. Clean face brick with warm water, detergent and fiber brushes.
 - 1. IF such cleaning is ineffective, use specified brick cleaning solution following the manufacturer's instructions.
 - 2. Cleaning solutions from Diedrich or ProSoCo may be used as necessary to remove stains from the masonry block and must be approved by ENGINEER prior to starting the work.
 - a. CONTRACTOR shall start with the mildest cleaning solution available and work to the stronger cleaning agents if the stains persist.
 - b. All solutions shall be tested in inconspicuous places to verify that they are not detrimental (change texture or color) to the appearance of the wall surface.
 - 3. Immediately flush surfaces thoroughly with clean, clear water.
 - 4. Also, immediately flush adjacent surfaces upon which solution has dropped or splashed. Do not use high-pressure power washers.
 - 5. The walls shall be cleaned as many times as necessary to remove stubborn and persistent stains.
 - 6. If stains are such that they cannot be successfully removed from the surface of the masonry unit, the masonry unit shall be cut from the wall and a new non-stained masonry unit matching the existing wall units shall be tuck-pointed into place.
- G. It is OWNER and ENGINEER's intention to have a uniform appearance in the final wall surfaces.
- H. For soiled stone surfaces, clean joints and exposed surfaces with fiber brush and soap powder and rinse thoroughly with water.
- I. Clean glazed face material units with detergent, warm water and fiber brushes.
- J. Remove all excess materials, debris, equipment, sample panels, etc. From site upon completion and acceptance of masonry work.
- K. Use non-metallic tools in cleaning operations.

3.16 Protection of Finished Work

- A. Protect finished Work under provisions of Section 01 4500.
- B. New masonry walls shall be protected at night to prevent the entrance of moisture into the exposed top of walls.
 - 1. Wall protection shall be provided until such time as the wall is permanently protected from moisture by subsequent construction.
 - 2. Walls not being actively worked on shall be protected from moisture continuously during the work interruption.
 - 3. Wall coverings shall be plastic or canvas as approved by ENGINEER.

- 4. Wall coverings shall be held in place securely to prevent being displaced by wind or weather conditions.
- C. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities.
- D. If masonry work becomes stained after the cleaning process has been completed and prior to acceptance of the completed building by OWNER, CONTRACTOR shall clean the walls again, in accordance with the above specified procedures, to make them acceptable.

End of Section

Division 05 Metals

Section 05 1200 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 3000: Cast-In-Place Concrete
- B. Section 04 0513: Mortar and Masonry Grout

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. AISC American Institute of Steel Construction
 - 2. ASTM- American Society for Testing and Materials
 - 3. AWS American Welding Society

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. AISC "Specifications for Structural Joints using ASTM A325 or A490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
 - 4. AWS D1.l "Structural Welding Code."
 - 5. ASTM A6 "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 "Standard Qualification Procedure." Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months. If recertification of welders is required, retesting will be 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 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: + 1/32 inch (0.8 mm).
 - 2. Members without ends milled for contact bearing which are framed to other members:
 - a. 30 feet (9 m) or less in length $\pm 1/16$ inch (1.5 mm).
 - b. Over 30 feet (9 m) in length $\pm 1/8$ inch (3 mm).

B. Straightness:

- 1. Structural members may vary from straightness within the tolerances allowed for wide flange shapes by ASTM Specification A6, 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 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 where the Work is located, 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 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 under Article 3.07 of this Section.

Part 2 Products

2.01 Structural Steel

- A. Rolled Steel Wide Flange and Tee Shapes: ASTM A 992.
- B. Other Rolled Steel Plates, Shapes, and Bars: ASTM A572, G50, unless otherwise indicated on the plans.
- C. Hollow Structural Sections: ASTM A500, Gr B. Steel Pipe: ASTM A53, Type E or S, Grade B.
- D. Anchor Bolts: ASTM A307, non-headed type unless otherwise indicated on the Plans.

2.02 Washers, Bolts, and Nuts

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

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 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 (50 mm) 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 steel work whether painted or not. Remove loose rust, loose mill scale, spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) SP-2 "Hand Tool Cleaning" and SP-3 "Power Tool Cleaning."
- 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 2.0 mils (50 pm). Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

Part 3 Execution

3.01 CONTRACTOR'S Verification

- A. CONTRACTOR must examine the areas and conditions under which structural steel work is to be installed and notify 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 CONTRACTOR.
- 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 CONTRACTOR prior to erection, 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 (3 mm) 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.
- B. Clean the bottom surface of base and bearing plates.
- C. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
- D. 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.
- E. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain.
- F. 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 Article 1.07 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 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 2.0 mils (50 μm).

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 requirements of the current building code at the place of the Work.
 - 2. 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. Testing agency may inspect structural steel at the plant before shipment; however, ENGINEER reserves the right 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 necessary to reconfirm any noncompliance of the original work and to show compliance of corrected work will be at CONTRACTOR'S expense.

- 6. Work determined to be defective by ENGINEER and/or local agencies regardless of all previous inspections, shall be corrected to the satisfaction of ENGINEER at no extra cost to 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. 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 defects found in the work.
 - c. Record work required and performed to correct deficiencies.
 - d. Perform visual inspection of welds complying with ASTM E164.
 - 2. Inspection of field bolted connections will be in accordance with AISC Specifications.

End of Section

Section 05 5000 Metal Fabrications

Part 1 General

1.01 Section Includes

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 1500: Concrete Accessories
- B. Section 03 3000: Cast-in-Place Concrete
- C. Section 05 1200: 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. AISC American Institute of Steel Construction
 - 2. ASTM American Society of Testing and Materials
 - 3. FS Federal Specifications
 - 4. OSHA Occupational Safety and Health Act

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. Top rail and supports of Guardrail System:
 - 1. Concentrated load of 200 lbs. (90 kg) applied at any point in any direction.
 - 2. Uniform load of 50 pounds per linear foot (75 kg/m) applied to the top rail horizontally with a simultaneous load of 100 lbs. per linear foot (150 kg/m) applied vertically downward.
- C. Handrail not serving as top rails:
 - 1. Horizontal concentrated load of 200 lbs. (90 kg) applied at any point.
 - 2. Uniform load of 50 pounds per linear foot (75 kg/m) applied at any point.
 - 3. Concentrated and uniform loads need not be assumed to act concurrently.
- D. Intermediate rails (except handrails), balusters and panel fillers:
 - 1. Horizontal applied normal load of 50 pounds (220 N) on an area not to exceed 1 square foot (925 cm2) including openings and space between rails. Reactions due to this loading are not required to be superimposed with those of preceding paragraphs.
- E. Gratings, hatches and stairs:

- 1. Uniformly distributed load of 200 lbs per square foot (975 kg/m2) of horizontal surface.
- 2. Maximum allowable deflection is 1/4 inch (5 mm) with 150 pounds per square foot (730 kg/m2) uniformly distributed load or 500 pounds (225 kg) concentrated load applied at mid-span.
- F. Stairway and ladder design shall conform to the latest Michigan OSHA 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 OSHA requirements for pull out and shear.

1.06 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 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.

1.07 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 CONTRACTOR.
- C. When requested by 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 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 OSHA 1910.27 standard for Climber Protection shall be submitted.
1.08 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 OWNER at the expense of 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 OWNER at the expense of CONTRACTOR.

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 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. 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
 - 2. Hardware of Steel or Iron: ASTM A153
 - 3. Assembled Steel Products: ASTM A123

2.02 Plates, Sheets, Shapes and Bars

- A. Steel: ASTM A36
- B. Aluminum:
 - 1. Plate and Sheet: Alloy 6061, Temper T6, ASTM B209
 - 2. Extruded Shapes and Bars: Alloy 6061 T6, ASTM B221
- C. Stainless steel: ASTM A316

2.03 Tubing

A. Steel:

- 1. Hot Formed Welded or Seamless Rolled: ASTM A501A1011, Grade 50
- 2. Cold Finished: Formed, ASTM A512A500, Grade C
- 3. Aluminum: Alloy 6061 T6, ASTM B221

2.04 Pipe

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

2.05 Expansion Anchor Bolts

A. Expansion anchor bolts shall be furnished and installed in accordance with Section 03 1500, Concrete Accessories.

2.06 Grating and Stair Treads

- A. Steel:
 - 1. Minimum 3/16-inch (4 mm) thick bearing bars manufactured from USS "Cor Ten" Steel with Blaw Knox Ponbake, Bordon Bo Ly, or approved equal finish. Stair treads shall have minimum 1 inch (25 mm) 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. 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 inches (40 mm) 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 inches (40 mm) diameter, schedule 40, black steel pipe of flush welded construction.

2.09 Ladders

A. 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 Fabrication

- A. General:
 - 1. Miscellaneous steel fabrications shall conform to AISC Code of Standard Practice. Welding where permitted and performed shall be in accordance with AWS Code for Welding in Building Construction.
 - 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. 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. 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.
 - 3. 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. 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 (6 m) or greater in length.
- D. Floor Hatches:
 - 1. Hatches shall be of sizes indicated on the Plans. Frame and door shall be aluminum with stainless steel hinges and pins unless otherwise called for on the plans. Provide spring counter balanced operators, automatic hold open arm with release handle and snap lock with removable handle. Hardware shall be stainless steel unless otherwise noted on the plans. Door shall have diamond checkered pattern.
 - 2. Frames shall be neatly mitered and shall have welded corners and anchors.
 - 3. 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.
- E. Lintels:
 - 1. Steel lintels shall be provided for openings as shown and scheduled. Lintels shall have not less than four (4) inches (100 mm) of bearing on each end and shall have an additional 1 inch (25 mm) of bearing at each end for each 1 foot

(300 mm) of clear span over four (4) feet (1200 mm), unless otherwise shown. Horizontal sections of lintels between the edge of the masonry opening and the end of the lintel shall be coped to allow for masonry joint not less than 1 inch (25 mm) deep measured from the interior and exterior faces of the masonry wall. See Lintel Schedule shown at the end of this Section.

- 2. Where steel plates are used in connection with structural shapes, they shall be welded to such structural shapes.
- F. Guard Chains:
 - 1. Where indicated on the Plans, chains shall be 3/16 inch (4 mm) 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.
- G. Guard Posts:
 - 1. Guard posts shall be 6 inch (150 mm) diameter, steel pipe conforming to ASTM A53, 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 total dry film thickness 4–6 mils

2.11 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 dirt, rust, and 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 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 3'-6" (1 m) below finished grade in a concrete foundation as shown on the Plans. Guard posts shall extend 5'-0" (1.5 m) above finished grade.

3.05 Installation of Railings

- A. Provide pipe railing system with maximum 8-foot (2400 mm) maximum post spacing and minimum 42-inch (1050 mm) railing height to top rail. Top rail of handrailing system shall be 34-inches (865 mm) high as measured from the leading edge of any tread. Provide minimum 3-inch (75 mm) 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 (25 mm) less in length than thickness of concrete.

3.06 Steel Lintel Schedule

See Next Page for Steel Lintel Schedule

| Wall Thickness | Opening Length | Description (inches and pounds) | Remarks |
|----------------|-----------------|--|--|
| 8" | Up to 3'-6" | 2 - 3-1/2"x3-1/2"x5/16" | See Notes Nos. 2 & 3 |
| | 3'-6" to 6'-6" | 2 - 4"x3-1/2"x5/16" | SLH, See Notes Nos. 2 & 3 |
| | 6'-6" to 12'-6" | W8x10 1- 5/16"x6-1/2" Plate | |
| | Up to 3'-6" | 3 - 3-1/2"x3-1/2"x5/16" | See Note No. 3 |
| 12" | 3'-6" to 6'-6" | 3 - 4"x3-1/2"x5/16" | SLH, See Note No. 3 |
| | 6'-6" to 12'-6" | W8 x 18 1 - 5/16"x10-1/2" Plate | |
| 14" | Up to 3'-6" | 2 - 3-1/2"x3-1/2"x5/16" 1 - 5"x3-1/2"x5/16" | LLH, See Note No. 3 |
| | 3'-6" to 6'-6" | 2 - 5"x3-1/2"x5/16" 1 - 5"x5"x5/16" | SLH, See Note No. 3 |
| | 6'-6" to 12'-6" | W8x18 1 - 5/16"x12-1/2" Plate | |
| 16" | Up to 3'-6" | 3 - 5"x3-1/2"x5/16" | LLH, See Notes Nos. 2 & 3 |
| | 3'-6" to 6'-6" | 3 - 5"x5"x5/16" | See Notes Nos. 2 & 3 |
| | 6'-6" to 12'-6" | W8 x 18 1 - 5/16"x14-1/2" Plate | Provide 1/4" Plate Stiffener, Each Side at 24" O.C. |
| 18" | Up to 3'-6" | W8x10 1 - 5/16"x16-1/2" Plate | |
| | 3'-6" to 6'-6" | W8x13 1 - 5/16"x16-1/2" Plate | Provide 1/4" Plate Stiffener, Each Side at 24" O.C. |
| | 6'-6" to 12'-6" | W8x18 1 - 5/16"x16-1/2" Plate | Provide 1/4" Plate Stiffener, Each Side at 24" O.C. |

NOTES: For openings larger than 12'-6", see Plans for size and shape. 1.

- 2.
- See Specifications for coping requirements. Provide 5/16" x (Wall Thickness 1-1/2") Plate, when seam is exposed to view. 3.
- SLH = Short Leg Horizontal. 4.
- LLH = Long Leg Horizontal. 5.

End of Section

Division 06 Wood, Plastics and Composites

Section 06 1014 Wood Blocking and Curbing

Part 1 General

1.01 Section Includes

- A. Wood blocking for miscellaneous supports.
- B. Preservative treatment of wood. Wood used in conjunction with roofing activities shall have preservative treatment approved for use by the approved roofing system manufacturer, for use with their single-ply membrane system.

1.02 Related Sections

- A. Section 06 1612: Framing and Sheathing
- B. 07 5600 Cold Fluid Applied Roofing

1.03 References

- A. ALSC American Lumber Standards Committee: Softwood Lumber Standards.
- B. AWPA (American Wood Preservers Association) U1 User Category System.
- C. AWPA (American Wood Preservers Association) C20 Structural Lumber Fire Retardant Treatment by Pressure Process.
- D. NFPA: National Forest Products Association.
- E. SPIB: Southern Pine Inspection Bureau.
- F. WCLIB: West Coast Lumber Inspection Bureau.
- G. WWPA: Western Wood Products Association.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.

1.05 Quality Assurance

- A. Perform Work in accordance with the following agencies:
 - 1. Lumber Grading Agency: Certified by ALSC.

Part 2 Products

2.01 Materials

- A. Lumber Grading Rules: NFPA.
- B. Miscellaneous Framing: Stress Group D, No. 2 Southern Pine or No. 2 Douglas Fir, 19 percent maximum moisture content, pressure preservative treat.

2.02 Accessories

- A. Fasteners and Anchors:
 - 1. Fasteners: Hot-dipped galvanized steel for wood locations, unless noted otherwise.
 - 2. Anchors: Hot-dipped Galvanized; Toggle bolt type for anchorage to hollow masonry; Expansion shield and lag bolt type for anchorage to solid masonry or concrete; Bolt or ballistic fastener for anchorages to steel. Note anchors shall be suitable for use with ACQ treated lumber.

2.03 Factory Wood Treatment

- A. Wood preservative:
 - 1. Materials shall be pressure treated to meet AWPA UC3B with 0.25 pounds per cubic foot, minimum retention, of Alkaline Copper Quat (ACQ).

Part 3 Execution

3.01 Framing

- A. Set members level and plumb, in correct position.
- B. Place horizontal members flat, crown side up.

3.02 Site Applied Wood Treatment

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply two coats of preservative treatment on wood where ends have been field cut for erection.
- C. Allow preservative to dry prior to erecting members.

End of Section

Section 06 1612 Framing and Sheathing

Part 1 General

1.01 Section Includes

- A. Roof sheathing.
- B. Wall sheathing.
- C. Exterior fascia and trim boards.
- D. Preservative treatment of wood.
- E. Miscellaneous framing and blocking.

1.02 Related Sections

- A. Section 07 3113: Asphalt Shingles
- B. Section 09 9000: Painting

1.03 References

- A. ALSC American Lumber Standards Committee: Softwood Lumber Standards.
- B. ANSI/AHA A135.4 Basic Hardboard.
- C. APA: American Plywood Association.
- D. AWPA (American Wood Preservers Association) C1 All Timber Products Preservative Treatment by Pressure Process.
- E. NFPA: National Forest Products Association.
- F. SPIB: Southern Pine Inspection Bureau.
- G. WCLIB: West Coast Lumber Inspection Bureau.
- H. WWPA: Western Wood Products Association.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide technical data on sheathing, wood preservative materials, and application instructions.
- C. Samples of Exposed to View Wood Members: Submit two samples, 6 x 6 inch (150 x 150 mm) in size illustrating wood grain, stain, and finish.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.05 Quality Assurance

- A. Perform Work in accordance with the following agencies:
 - 1. Lumber Grading Agency: Certified by ALSC; WWPA.
 - 2. Plywood Grading Agency: Certified by APA.
- B. In lieu of grade stamping exposed to view lumber and plywood, submit manufacturer's certificate under provisions of Section 01 6000, Product Requirements, that products meet or exceed specified requirements.

1.06 Delivery, Storage, And Handling

A. Deliver, store, protect, and handle products to site under provisions of 01 6000, Product Requirements.

Part 2 Products

2.01 Lumber Materials

- A. Lumber Grading Rules: NFPA.
- B. Miscellaneous Framing: Stress Group D, No. 2 Southern Pine or No. 2 Douglas Fir, 19 percent maximum moisture content.
- C. Lumber in contact with masonry, concrete or within one foot of grade or ground contact shall be pressure preservative treat.
- D. Fascia and Trim Boards: Match existing.

2.02 Sheathing Materials

A. Roof Sheathing: Exterior and APA Structural 1 rated Plywood Sheathing, minimum Span Rating 40/20.

2.03 Sheathing and Underlayment Locations

A. Sloped Roof Sheathing: 5/8 inch (12 mm) thick, 48 x 96 inch (1 200 x 2 400 mm) sized sheets.

2.04 Accessories

- A. Fasteners and Anchors:
 - 1. Fasteners: Hot-dipped galvanized steel.
 - 2. Anchors: Hot-dipped galvanized. Toggle bolt type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Bolt or ballistic fastener for anchorages to steel. Note anchors shall be suitable for use with ACQ treated lumber.
- B. Die Stamped Connectors: Hot dipped galvanized steel.

2.05 Factory Wood Treatment

- A. Wood preservative:
 - 1. Materials, as specified herein, shall be pressure treated to meet AWPA UC3B with 0.25 pounds per cubic foot, minimum retention, of Alkaline Copper Quat (ACQ).

Part 3 Execution

3.01 Sheathing

- A. Secure roof sheathing perpendicular to framing members with ends staggered and sheet ends over firm bearing. Use sheathing clips between sheets between roof framing members.
- B. Install plywood to two spans continuous.

3.02 Site Applied Wood Treatment

- A. Preservative treated lumber that is cut at the site shall have the cut edges preservative treatment in accordance with manufacturer's instructions prior to installation if the cut edge will not be accessible for post installation field treatment.
- B. Brush apply two coats of preservative treatment on wood in contact with cementitious materials, roofing and related metal flashings and treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

End of Section

Section 06 8026 Glass-Fiber Reinforced Products and Fabrications

Part 1 General

1.01 Scope of Work

- A. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass reinforced polymer (FRP) products as specified herein.
 - 1. FRP Pultruded Gratings and Treads
 - 2. FRP Structural Shapes and Plate
 - 3. FRP Ladders and Cages
 - 4. FRP Building Panel System
 - 5. FRP Planks

1.02 Reference Standards

- A. Design, manufacture, and installation of this equipment shall meet or exceed the applicable provisions and recommendations of the following codes and standards authorities:
 - 1. ASTM American Society of Testing and Materials.

1.03 Quality Assurance

- A. Material covered by these specifications shall be furnished by an ISO-9001:2000 certified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.
- B. Manufacturer shall have not less than ten (10) years of experience in the application, design, and manufacture of fiberglass reinforced plastics, and manufacturer shall submit a list of not less than twenty-five (25) installations as evidence of meeting the experience requirement.
- C. Substitution of any component or modification of system shall be made only when approved by ENGINEER.
 - 1. If submitted product requires arrangement differing from that indicated on the drawings or specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of proposed product with prequalification package required above.
 - 2. Any changes are at no additional compensation and CONTRACTOR shall be responsible for necessary engineering costs for redesign by ENGINEER.
- D. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.
- E. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.04 Design Criteria

- A. The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable.
- B. Design live loads of FRP gratings and floor panels shall not be less than 100 PSF uniformly distributed unless specifically stated otherwise in drawings and/or supplementary conditions. Grating and floor panel deflection at the center of a simple span not to exceed 0.25 inches.
- C. Structural members shall be designed to support all applied loads. Deflection in any direction shall not be more than L/180 of span for structural members. Connections shall be designed to transfer the loads.

1.05 Submittals

- A. Shop drawings of fabricated pultruded gratings and treads, structural shapes and plate, building panel systems, planks, anchors, and appurtenances shall be submitted to ENGINEER for approval in accordance with the requirements of Section 01 3000.
 - 1. Fabrication shall not start until receipt of ENGINEER's approval marked "Approved As Submitted" or "Approved As Noted".
- B. Manufacturer's catalog data showing:
 - 1. Dimensions, spacings, and construction of grating
 - 2. Materials of construction
- C. Detail shop drawings showing:
 - 1. Dimensions
 - 2. Sectional assembly
 - 3. Location and identification mark
 - 4. Size and type of supporting frames required
 - 5. Connections showing rivet, bolts and surfaces to be adhered.
- D. Samples of each type of product shall be submitted for approval prior to placement of purchase orders.

1.06 Delivery, Storage & Handling

- A. Systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Materials and equipment necessary for the fabrication and installation of pultruded gratings and treads, structural shapes and plate, building panel systems, planks, and appurtenances shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun.

1. Material which, in the opinion of ENGINEER, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and CONTRACTOR shall receive no compensation for the damaged material or its removal.

Part 2 Products

2.01 General

- A. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification.
- B. Materials shall be of the kind and quality specified.
- C. FRP products shall be manufactured using a pultruded process utilizing isophthalic polyester resin with flame retardant and ultraviolet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. Flame retardant FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E-84.
- D. If required, after fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating.
- E. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating can be applied.
- F. Exposed surfaces shall be smooth and true to form.

2.02 Pultruded Gratings and Treads:

- A. General:
 - 1. Grating shall be shipped from the manufacturer, palletized and banded with exposed edges protected to prevent damage in shipment. Each piece shall be clearly marked showing manufacturer's applicable drawing number.
- B. Acceptable Manufacturers:
 - 1. Strongwell
 - 2. Amtech
 - 3. McNichols
 - 4. ENGINEER-approved equal.
- C. Design:
 - 1. Panels shall be 1-1/2 inches deep and sustain a deflection of no more than 0.25 inches under a uniform distributed load of 100 PSF for the span lengths shown on the plans.
 - 2. Bearing bars shall be joined into panels by passing continuous length fiberglass pultruded cross rods through the web of each bearing bar. A continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross rod spacers to the web of the bearing bars.

- 3. Continuous chemical bonding shall be achieved between the cross rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars.
- 4. Stair treads shall be capable of withstanding a uniform load of 100 pounds per square foot or a concentrated load of 300 pounds on an area of 4 square inches located in the center of the tread, whichever produces greater stress.
- 5. Top surface of all panels shall have a non-skid grit affixed to the surface by an epoxy resin followed by a top coat of epoxy resin.
- 6. Panels shall be fabricated to the sizes shown on the drawings.
- 7. Hold down clamps shall be type 316L stainless steel saddle clips. Use 2 at each support with a minimum of 4 per panel.
- 8. Color shall be gray, stair nosings shall be painted safety yellow.
- 9. Bearing bars that are to be exposed to UV shall be coated with polyurethane coating of a minimum thickness of 1 mil.

2.03 Products

A. FRP grating and stair treads shall be fabricated from bearing bars and cross rods manufactured by the pultrusion process. Glass fiber reinforcement for the bearing bars shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. Synthetic surface veil shall be the outermost layer covering the exterior surfaces.

2.04 Fiberglass Grating and Stair Treads

- A. Fiberglass grating and stair treads shall be made from a chemical resistant, fire retardant polyester resin system with antimony trioxide added to meet the flame spread rating of 25 or less in accordance with ASTM E84 testing and meet the self-extinguishing requirements of ASTM D635. UV inhibitors shall be added to the resin.
- B. Cut and machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the bearing bars and cross rods.
- C. Panels shall be fabricated to the sizes shown on the approved shop drawings.

2.05 Structural Shapes and Plate

- A. Material:
 - 1. Structural shapes and plate shall be made from isophthalic polyester resin with fire retardant additives to meet a flame spread rating of less than 25 per ASTM E84 and meet the self-extinguishing requirements of ASTM D635. Structural shapes shall contain a UV inhibitor.
- B. Process:

- 1. Manufactured by the pultrusion process.
- 2. Structural FRP members' composition shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50% glass by weight. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats or stitched reinforcements shall be used internally for transverse strength.
- 3. Mechanical properties shall meet or exceed the values listed in Table 1 at the end of this Section.

2.06 FRP Building Panel System

- A. Approved Fabricators:
 - 1. Strongwell
 - 2. Bristol Division (Bristol, VA)
 - 3. Highlands Division (Abingdon, VA)
 - 4. Chatfield Division (Chatfield, MN)
 - 5. ENGINEER-approved equal.
- B. Materials:
 - 1. Each panel shall be manufactured by the pultrusion process utilizing isophthalic polyester resin with flame retardant and UV inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. FRP panel shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E84.
 - 2. The 3-way connector, hanger, 45° connector, toggle connector and end cap required to install the building panel system shall be manufactured by the pultrusion process, and achieve a flame spread rating of 25 or less in accordance with ASTM test method E84.
- C. The following minimum mechanical properties shall apply:

| Properties | ASTM Test Method | Units | Value | | |
|-----------------------|------------------|----------------------|------------------|--|--|
| Flexural Strength, LW | D790 | psi N/mm2 | 24,500 169 | | |
| Flexural Strength, CW | D790 | psi N/mm2 | 8,200 56.55 | | |
| Flexural Modulus, LW | D790 | 106 psi 103 N/mm2 | 0.885 0.0061 | | |
| Flexural Modulus, CW | D790 | 106 psi 103 N/mm2 | 0.646 0.00446 | | |
| Tensile Strength | D638 | psi N/mm2 | 31,100 214.5 | | |
| Tensile Modulus | D638 | 106 psi 103 N/mm2 | 2.486 0.017 | | |
| Short Beam Shear | D2344 | psi N/mm2 | 3,190 22 | | |

- D. Connections:
 - 1. Panels utilize integrally molded longitudinal grooves into which a connector or toggle is inserted during assembly.
 - 2. 3-way and 45^o connectors are utilized in the system to turn corners and facilitate joining walls and sides.
 - 3. Toggles are utilized to lock panels and connectors.
 - 4. For permanent structures, adhesives are applied in the small grooves along the length of the panel. Toggles secure components (panels and connectors) and create even pressure until adhesive is cured.

Part 3 Execution

3.01 Preparation

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from infiltration of water and debris.

3.02 Inspection and Testing

- A. ENGINEER shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.
- B. Labor, power, materials, equipment and appurtenances required for testing shall be furnished by CONTRACTOR at no cost to OWNER.

3.03 Installation - General

- A. Fastening to in-place construction:
 - 1. Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by ENGINEER.
- B. Cutting, fitting and placement:
 - 1. Perform cutting, drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.
- C. Provide temporary bracing or anchors in form work for items that are to be built into concrete masonry or similar construction.

3.04 FRP Installation

- A. If required, field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer. Sealing of the edges shall prevent premature fraying at the field cut edges.
- B. Install items specified as indicated and in accordance with manufacturer's instructions.

Continued on Next Page

Table 1 - Minimum Ultimate Coupon Properties (UN) for Fiberglass Pultruded Material

| Properties | ASTM Test Method | Units/ Value | Series 500/525 Shapes | Series 625 Shapes | 1/8" 3.175 mm | Series 500/525 Plate⊗ 3/16" -1/4" 4.76-6.35 mm | 3/8"-1" 9.5-25.4 mm | 1/8" 3.175 mm | Series 625 Plate⊗ 3/16"-1/4" 4.76-6.35 mm | 3/8"-1" 9.5-25.4 mm |
|--|---------------------|-----------------|--------------------------|-------------------------|------------------|--|------------------------|------------------|---|------------------------|
| Mechanical | | | | | | | | | | |
| Tensile Stress, LW | D638 | psi | 30,000 | 30,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| | | N/mm2 | 207 | 207 | 138 | 138 | 138 | 138 | 138 | 138 |
| Tensile Stress, CW | D638 | psi | 7,000 | 7,000 | 7,500 | 10,000 | 10,000 | 7,500 | 10,000 | 10,000 |
| | | N/mm2 | 48.3 | 48.3 | 51.7 | 68.9 | 68.9 | 51.7 | 68.9 | 68.9 |
| Tensile Modulus, LW | D638 | 106 psi | 2.5 | 2.6 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| | | 103N/mm2 | 17.2 | 17.9 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 |
| Tensile Modulus, CW | D638 | 106 psi | .8 | .8 | .7 | .9 | 1.4 | 1 | 1 | 1.4 |
| | | 103N/mm2 | 5.52 | 5.52 | 4.83 | 6.21 | 9.65 | 6.89 | 6.89 | 9.65 |
| Compressive Stress, LWX | D695 | psi | 30,000 | 30,000 | 24,000 | 24,000 | 24,000 | 24,000 | 24,000 | 24,000 |
| | | N/mm2 | 207 | 207 | 165 | 165 | 165 | 165 | 165 | 165 |
| Compressive Stress, CW | D695 | psi | 15,000 | 16,000 | 15,500 | 16,500 | 20,000 | 16,500 | 17,500 | 17,500 |
| | | N/mm2 | 103 | 110 | 107 | 114 | 138 | 114 | 121 | 121 |
| Compressive Modulus, LW | D695 | 106 psi | 2.5 | 2.6 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| | | 103N/mm2 | 17.2 | 17.9 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 |
| Compressive Modulus, CW | D695 | 106 psi | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | 103N/mm2 | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 |
| Flexural Stress, LW3 | D790 | psi | 30,000 | 30,000 | 35,000 | 35,000 | 30,000 | 35,000 | 35,000 | 30,000 |
| | | N/mm2 | 207 | 207 | 241 | 241 | 207 | 241 | 241 | 207 |
| Flexural Stress, CW | D790 | psi | 10,000 | 10,000 | 13,000 | 15,000 | 18,000 | 13,000 | 15,000 | 18,000 |
| | | N/mm2 | 68.9 | 68.9 | 89.6 | 103 | 124 | 89.6 | 103 | 124 |
| Flexural Modulus, LW \cup | D790 | 106 psi | 1.6 | 1.6 | 1.8 | 2 | 2 | 1.8 | 2 | 2 |
| | | 103N/mm2 | 11.0 | 11.0 | 12.4 | 13.8 | 13.8 | 12.4 | 13.8 | 13.8 |
| Flexural Modulus, CW | D790 | 106 psi | 0.8 | 0.8 | 0.9 | 1.1 | 1.4 | 1 | 1.1 | 1.4 |
| | | 103N/mm2 | 5.52 | 5.52 | 6.21 | 7.58 | 9.65 | 6.89 | 7.58 | 9.65 |
| Modulus of Elasticity೫ | full | 106 psi | 2.6 | 2.8 | | | | | | |
| | section | 103N/mm2 | 17.9 | 19.3 | | | | | | |
| Modulus of Elasticity >4" R | full | 106 psi | 2.5 | 2.5 | | | | | | |
| >102 mm | section | 103N/mm2 | 17.2 | 17.2 | | | | | | |
| Parallel Compressive Shear Stress, LW $\wp \cup$ | D3846 | psi | 3,000 | 3,000 | | | | | | |
| | | N/mm2 | 20.7 | 20.7 | | | | | | |
| Shear Modulus, LW⊗∪ | | 106 psi | .425 | .425 | | | | | | |
| | | 103N/mm2 | 2.93 | 2.93 | | | | | | |
| Short Beam Shear, LW \cap \cup | D2344 | psi | 4,500 | 4,500 | | | | | | |
| | | N/mm2 | 31.0 | 31.0 | | | | | | |
| Ultimate Bearing Stress, LW | D953 | psi | 30,000 | 30,000 | 32,000 | 32,000 | 32,000 | 32,000 | 32,000 | 32,000 |
| | | N/mm2 | 207 | 207 | 220.6 | 221 | 221 | 221 | 221 | 221 |
| Poisson's Ratio, LW \cup | D3039 | in/in | .33 | .33 | .31 | .31 | .31 | .32 | .32 | .32 |
| | | mm/mm | .330 | .330 | .310 | .310 | .310 | .320 | .320 | .320 |
| Notched Izod Impact, LW | D256 | ft-lbs/in | 25 | 25 | 15 | 10 | 10 | 15 | 10 | 10 |
| | | J/mm | 1.33 | 1.33 | .988 | 1.07 | 1.07 | .988 | 1.07 | 1.07 |
| Notched Izod Impact, CW | D256 | ft-lbs/in | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| | | J/mm | .214 | .214 | .267 | .267 | .267 | .267 | .267 | .267 |

| Properties | ASTM Test Method | Units/ Value | Series 500/525 Shapes | Series 625 Shapes | 1/8" 3.175 mm | Series 500/525 Plate⊗ 3/16" -1/4" 4.76-6.35 mm | 3/8"-1" 9.5-25.4 mm | 1/8" 3.175 mm | Series 625 Plate⊗ 3/16"-1/4" 4.76-6.35 mm | 3/8"-1" 9.5-25.4 mm |
|---|---------------------|------------------------------------|--------------------------|----------------------|----------------------|--|------------------------|----------------------|---|------------------------|
| Physical | | | | | | | | | | |
| Barcol Hardness⊕ | D2583 | _ | 45 _k o | 45 <i>℘</i> | 40 | 40 | 40 | 40 | 40 | 40 |
| 24 HR Water Absorption \varnothing | D570 | % Max by wt | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Density | D792 | lbs/in3 10-3g/mm3 | .062070 1.72-1.94 | .062070 1.72-1.94 | .060068 1.66-1.88 | .060068 1.66-1.88 | .060068 1.66-1.88 | .060068 1.66-1.88 | .060068 1.66-1.88 | .060068 1.66-1.88 |
| Coefficient of Thermal Expansion, LW \cup | D696 | 10-5in/in/oF 10-6in/in/oC | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 | 1.2 7.0 |
| Thermal Conductivity \cup | C177 | BTU-in/ ft2/hr/oF W (m * ºK) | 4 .58 | 4 .58 | | | | | | |
| Electrical | | | | | | | | | | |
| Arc Resistance, LW \cup | D495 | seconds | 120 | 120 | | | | | | |
| Dielectric Strength, LW \cup | D149 | KV/in KV/mm | 35 1.38 | 35 1.38 | 35 1.38 | 35 1.38 | 35 1.38 | 35 1.38 | 35 1.38 | 35 1.38 |
| Dielectric Strength, PF2 | D149 | volts/mil | 200 | 200 | 200 | N.T. | N.T. | 250 | N.T. | N.T. |
| Flammability 🕀 | | | | | | | | | | |
| Flammability Classification (1/16") | UL94 | vo | | | | | | | | |
| Tunnel Test | E-84 | 25 Max | | | | | | | | |
| NBS Smoke Chamber | E-662 | 650-700 (typical) | | | | | | | | |
| Flammability | D635 | Self Extinguishing | | | | | | | | |
| UL Thermal Index | Generic | 130oC | | | | | | | | |
| British Fire Test | BS 476-7 | Class 1 | | | | | | | | |

Table 1 - Minimum Ultimate Coupon Properties (UN) for Fiberglass Pultruded Material... continued

All values are minimum ultimate properties from coupon tests except as noted:

ℜ This value is determined from full section simple beam bending of EXTREN® structural shapes.

3 The shear stress test results will change radically if the notched orientation is altered. The value in this chart represents the test configuration where the notches are machined parallel to the reinforcing mat. For notches machined perpendicular to the reinforcing mat, this value would be two to three times larger.

R The Shear Modulus value has been determined from tests with full sections of EXTREN® structural shapes. (See the Strongwell Design Manual for further information.)

℘ Value would be 50 if the surfacing veil were not there.

 \otimes Plate compressive stress/modulus measured edgewise and flexural stress/modulus measured flatwise.

 \oplus Values apply to Series 525 and 625.

 \varnothing Measured as a percentage maximum by weight.

 \cap Span to depth ratio of 3:1; EXTREN® angles will have a minimum value of 4,000 psi and the I/W shapes are tested in the web.

 \cup Typical values because these are shape and composite dependent tests.

I This is a typical value which varies with composite thickness.

LW = Lengthwise

CW = Crosswise

End of Section

PF = Perpendicular to laminate face N.T. = Not Tested Division 07 Thermal and Moisture Protection

Section 07 1000 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 ENGINEER in accordance with Section 01 3300.

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 or polyurethane foam of thickness shown on the Plans; minimum compressive strength of l8psi (125 kPa); maximum water vapor transmission of 1.1 per inch; conforming to Federal Specification HH-I-524B, Type 11, Class B.

2.02 Vapor Barrier

A. Use a 6-mi1 (150 pm), 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 Acceptable Manufacturers

- A. Perimeter Insulation: Dow "Styrofoam"; United States Gypsum Company "Formula R; or ENGINEER approved equal.
- B. Vapor Barrier: Polyamerica "Visqueen"; "Durethene"; or 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 brick and block surfaces to be backfilled against.

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 (150 mm) 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-toweather 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-gallon per 100 square feet (4 L/10 m²) 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-gallon per 200 square feet (2 L/10 m²) in accordance with manufacturer's recommendations. Do not stain or discolor surfaces or allow runs or waves in applied material.

End of Section

Section 07 3113 Asphalt Shingles

Part 1 General

1.01 Section Includes

- A. Granular surfaced, fiberglass laminated asphalt shingle roofing.
- B. Ice dam protection, moisture shedding underlayment, eave, valley, and ridge protection.
- C. Prefabricated continuous ridge vents.

1.02 Related Sections

- A. Section 06 1612: Framing and Sheathing
- B. Section 07 6000: Flashing and Sheet Metal

1.03 References

- A. ASTM D3018 Class A Asphalt Shingles Surfaced with Mineral Granules.
- B. ASTM D3462 Asphalt Shingles Made From Glass Felt and Surfaced With Mineral Granules.
- C. ASTM D4586 Asphalt Roof Cement, Asbestos Free.
- D. NRCA Steep Roofing Manual.
- E. UL 790 Tests for Fire Resistance of Roof Covering Materials.

1.04 Submittals

- A. Section 01 3300, Submittal Procedures: Procedures for submittals.
- B. Shop Drawings: Indicate specially configured metal flashings, jointing methods and locations, fastening methods and locations, and installation details.
- C. Product Data: Provide data indicating material characteristics, performance criteria and limitations.
- D. Samples: Submit two samples of each shingle color indicating color range and finish texture/pattern; for color selection.
- E. Manufacturer's Instructions: Indicate installation criteria and procedures.
- F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.05 Quality Assurance

- A. Perform Work in accordance with NRCA Steep Roofing Manual.
- B. Installer: Company specializing in re-roofing work on Historical Structures, similar to this project scope, with a minimum of five (5) years' documented experience.

1.06 Regulatory Requirements

A. Conform to applicable code for ASTM D3018 Class A for shingle types specified.

1.07 Environmental Requirements

- A. Section 01 6000, Product Requirements: Environmental conditions affecting products on site.
- B. Do not install eave edge protection and shingles when surface, or ambient air, or wind chill temperatures are below 45 degrees Fahrenheit (7 degrees Celsius).

1.08 Warranty

A. Provide limited Lifetime warranty under provisions of Section 01 7700, Closeout Procedures.

Part 2 Products

2.01 Asphalt Shingles

- A. Manufacturers:
 - 1. Certainteed Landmark Shingles
 - 2. GAF Timberline NS Roofing Shingles
- B. Asphalt shingles: ASTM D3018, Class A, Type I (self-sealing), UL Rating of A and Wind Resistance Label; glass fiber mat base, mineral granular surface type.
- C. Color to match existing shingles.
- D. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Accessories

- A. Nails: Standard round wire shingle type hot dipped zinc coated steel type, of sufficient length to penetrate through roof sheathing.
- B. Prefabricated ridge vents: Cor-A-Vent V-600 (8.5" width), shingle over type, black polypropylene, 1 inch low profile with screened vents, weather protection baffles, hinged assembly to match any roof slope. Provide solid matching caps, all discontinuous ends.
- C. Grace Co., Ice and Water Shield Eave (Ice Dam) Membrane Protection; Sheet barrier of rubberized asphalt bonded to sheet polyethylene, 40 mil (1 mm) total thickness, with strippable treated release paper.
- D. Roll roofing: Georgia Pacific GP-30 Residential, ASTM D4869 Type II.
- E. Protective Underlayment No. 15 asphalt saturated felt, 2 layers required.
- F. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.03 Flashing Materials

- A. Sheet Flashings: Specified in Section 07 6000, Flashing and Sheet Metal
- B. Bituminous Paint: Acid and alkali resistant type; black color.

Part 3 Execution

3.01 Examination

- A. Section 01 3119, Project Meetings: Verification of existing conditions prior to beginning work.
- B. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.
- C. Verify roof openings are correctly framed.
- D. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.02 Preparation

- A. Broom clean deck substrate and verify that it ready to receive roofing materials.
- B. Replace any deteriorated deck boards, soffits, and fascias per plans prior to installation of new materials.

3.03 Installation - Eave (Ice Dam) Protection

- A. Place eave edge and gable edge metal flashings tight with fascia boards. Weather lap joints 2 inches (50 mm) and seal with plastic cement. Secure flange with nails spaced 12 inches (300 mm) oc.
- B. Apply rubberized asphalt/polyethylene sheet eave protection in accordance with manufacturer's instructions.
- C. Extend eave protection membrane minimum 2 ft up-slope beyond exterior face of exterior wall.
- D. Install sheet protection membrane around dormers in valleys.

3.04 Installation - Protective Underlayment

- A. Place first ply of underlayment over roof area, including valley areas protected by membrane ice shield, with ends and edges weather lapped minimum 6 inches (150 mm). Stagger end laps of each consecutive layer. Nail in place.
- B. Place a second ply of underlayment over first layer with ends and edges weather lapped minimum 6 inches (150 mm). Stagger end laps of each consecutive layer.
- C. Install protective underlayment perpendicular to slope of roof and weather lap minimum 6 inches (100 mm) over perimeter eave protection.
- D. Weather lap and seal watertight with plastic cement items projecting through or mounted on roof.

3.05 Installation - Valley Protection

- A. Apply rubberized asphalt/polyethylene sheet eave protection in accordance with manufacturer's instructions.
- B. In addition to two layers of felt underlayment as specified above, install layer of roll roofing, minimum 3 feet wide, centered on valley prior to installation of shingles.

3.06 Installation - Metal Flashing and Accessories

- A. Weather lap joints minimum 2 inches (50 mm) and seal weather tight with plastic cement.
- B. Secure in place with nails at 12 inches (300 mm) on center Conceal fastenings.
- C. Flash and seal work weather tight, projecting through or mounted on roofing with plastic cement.
- D. Provide standard sheet metal edge flashing on all exposed edges of roof; refer to Drawings details. Exposed edges shall be hemmed, unless noted otherwise.

3.07 Installation - Asphalt Shingles

- A. Install shingles in accordance with manufacturer's instructions.
- B. Project first course of shingles 3/4 inch (19 mm) beyond fascia boards.
- C. Extend shingles 1/2 inch (13 mm) beyond face of gable edge fascia boards.
- D. Extend shingles on one slope across valley and fasten. Trim shingles from other slope 2 inches (50 mm) from valley center line to achieve closed cut valley, concealing the valley protection.
- E. Cap ridges without vents with individual shingles, maintaining 5 inch (125 mm) weather exposure.
- F. Cap ridges with vents using individual shingles installed per vent manufacturer's recommendations.

3.08 Field Quality Control

A. Section 01 4500, Quality Control: Field inspection

3.09 Protection of Finished Work

- A. Section 01 7700, Closeout Procedures: Protecting installed work.
- B. Do not permit traffic over finished roof surface.

End of Section

Section 07 5310 Single Ply Roofing - Fully Adhered - Conventional

Part 1 General

1.01 Section Includes

- A. Membrane roofing, base flashings roofing membrane and counter flashings.
- B. Pre-fabricated pipe supports for placement on roofing membrane, to support utilities serving existing roof-top equipment.
- C. Rigid insulation.

1.02 Related Sections

- A. Section 01 1100: Summary of Work.
- B. Section 01 3300: Submittal Procedures.
- C. Section 06 1014: Wood Blocking and Curbing: Wood nailers.
- D. Section 07 6000: Flashing and Sheet Metal: Miscellaneous metal flashing fabrications.

1.03 References

- A. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- B. ASTM D412 Rubber Properties in Tension.
- C. ASTM D471 Standard Test Method for Rubber Property Effect of Liquids.
- D. ASTM D624 Rubber Property Tear Resistance.
- E. ASTM E96 Water Vapor Transmission of Materials.
- F. FM 4470 (Factory Mutual Engineering Corporation) Roof Assembly Classifications.
- G. NRCA (National Roofing Contractors Association) Roofing and Waterproofing Manual.
- H. UL 790 Fire Hazard Classifications.

1.04 System Description

- A. Elastomeric Sheet Membrane Conventional Roofing System: One ply membrane system with insulation.
- B. Provide tapered insulation for saddles/crickets as necessary to direct flow for positive drainage around roof penetrations.

1.05 Submittals for Review

- A. Product Data: Provide characteristics on membrane materials, flashing materials, insulation, and adhesive.
- B. Shop Drawings: Indicate setting plan for insulation, joint and termination detail conditions and conditions of interface with other materials; termination condition at existing sidewalls.
- C. Samples: Submit two 6 x 6 inch in size illustrating insulation.

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1.06 Submittals for Information

- A. Section 01 3300, Submittal Procedures: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate special precautions required for seaming the membrane.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Field Reports: Submit under provisions of Section 01 4500.
- E. Reports: Indicate procedures followed; ambient temperatures, humidity, wind velocity during application.

1.07 Quality Assurance

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with ten (10) years' experience.
- B. Installer:
 - 1. Company specializing in performing the work of this section with ten (10) years' experience and approved by system manufacturer.
 - 2. Installer must be certified in the last 3 years by the system manufacturer to install their provided system per these specifications in accordance with the following:
 - a. Firestone: Master Contractor
 - b. Carlisle: Perfection Council or Award or ESP Award
 - c. Johns Mansville: Summit Club Member (or higher)

d. **Provide documentation regarding certification as part of bid** submittal.

C. Perform Work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

1.08 Regulatory Requirements

- A. Conform to applicable Michigan Building Code for roof assembly fire hazard requirements.
- B. UL 790: Class A Fire Hazard Classification.
- C. FM 4470: Roof Assembly Classification, of Class 1 Construction, wind uplift requirement of 1-90, in accordance with FM Construction Bulletin 1-28.

1.09 Pre-Installation Meeting

- A. Section 01 3119, Project Meetings: Pre-installation meeting.
- B. Convene one week before starting work of this section.

1.10 Delivery, Storage, and Protection

- A. Section 01 6000, Product Requirements: Transport, handle, store, and protect products.
- B. Store products in weather protected environment, clear of ground and moisture.

1.11 Environmental Requirements

- A. Section 01 6000, Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply roofing membrane during inclement weather and ambient temperatures below 32 degrees Fahrenheit or above 95 degrees Fahrenheit.
- C. Do not apply roofing membrane to damp or frozen deck surface.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.12 Coordination

- A. Coordinate work under provisions of Section 01 3119.
- B. Coordinate the work with the installation of associated metal flashings, as the work of this section proceeds.

1.13 Warranty

- A. Manufacturer Provide 20-Year, Non-Prorated Total System Roofing Warranty covering roof membrane, flashings and insulation/cover board for all new installations. Roofing Manufacturer representative shall sign off and approve the roofing installation prior to warranty period commencing.
- B. Contractor Upon completion, Contractor shall also provide a 2-Year Workmanship Warranty to cover all leaks due to defective workmanship or materials. Warranty shall include metal flashing installation; warranty shall list location of flashings and total lengths of installation.

Part 2 Products

2.01 Manufacturers – Membrane Material

- A. Firestone RubberGard EPDM Membrane (60 mil)
- B. Johns Manville 60NR
- C. Carlisle SureSeal (60 mil)
- D. Substitutions None permitted.

2.02 Membrane and Associated Materials

- A. Membrane: EPDM non-reinforced, 0.060 inch thick, utilizing maximum roll width to reduce number of seams; color black.
- B. Seaming Materials: As recommended by membrane manufacturer.

2.03 Attachment Materials

- A. Surface Conditioner: As recommended by membrane manufacturer, compatible with membrane.
- B. Membrane Adhesives: As recommended by membrane manufacturer.
- C. Insulation Adhesive for Concrete Deck: As recommended by membrane manufacturer.
- D. Mechanical Fasteners for Metal Deck: Non-corrosive, as recommended by membrane manufacturer.

- E. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.
- F. See "Accessories" for fasteners, termination bars and reglets.

2.04 Insulation Materials

- A. Manufacturers roofing membrane manufacturer shall approve all insulation and fastening components used with their roofing system.
- B. Thermal resistance ratings specified are based on ASTM C1289 (2011) and are presented as a Long Term Thermal Resistance (LTTR) value, reflecting a product's 15 year weighted average of the foam's thermal resistance. Submittals shall indicate R-Value in LTTR format.
- C. All insulation shall be approved by the roofing manufacturer for use with their roofing system, to obtain and maintain the warranty specified. Insulation shall be applied in minimum two layers (including the cover board), unless approved otherwise by roofing manufacturer:
 - 1. Type 1 (High Density Cover Board): High Density rigid cover board shall be used over rigid insulation. Material to be approved for warranty requirements specified.
 - 2. Type 2 (Thermal Insulation): Polyisocyanurate foam core bonded to universal fiber glass reinforced facer sheets.
 - 3. Type 3 (Tapered Thermal Insulation): Similar to Type 2, polyisocyanurate foam core bonded to universal fiber glass reinforced facer sheets, tapered board.
- D. Type 1: ASTM C1289, Type II, Class IV, Grade 2, high density polyisocyanurate rigid cover board; with the following characteristics:
 - 1. Board Density: Minimum 100 PSI.
 - 2. Board Size: 48 x 48 inch or 48 x 96 inch.
 - 3. Board Thickness: 1/4 inch to 1/2 inch (as required for roofing system to be provided.)
 - 4. Board Edges: Square.
- E. Type 2: ASTM C1289, Type II, Class I, Grade 2 polyisocyanurate board insulation with the following characteristics:
 - 1. Board Density: Minimum 20 PSI.
 - 2. Board Size: 48 x 48 or 48 x 96 inch
 - 3. Board Thickness per Layer: 1 inch minimum.
 - 4. Thermal Value LTTR: Minimum R-Value of 5.7 for 1 inch board.
 - 5. Board Edges: Square.
- F. Type 3: ASTM C1289, Type II, Class I, Grade 2 tapered, polyisocyanurate board insulation with the following characteristics:
 - 1. Board Density: Minimum 20 PSI.
 - 2. Board Size: 48 x 48 inch
- 3. Slope: 1/8 to 1/4 inch per foot as shown on the Drawings.
- 4. Board Thickness: 1/2 inch to 4 inch in a single layer.
- 5. Thermal Value LTTR: Minimum R-Value of 5.7 based on a typical tapered board thickness of 1 inch or greater.
- 6. Board Edges: Square.

2.05 Flashings

A. Flexible Flashings: Same material as membrane EPDM; black color, as recommended by the manufacturer.

2.06 Accessories

- A. Sealants: As recommended by membrane manufacturer to maintain warranty specified.
- B. Stack Boots: Flexible boot and collar for pipe stacks through membrane.
- C. Termination Bars: Stainless steel or aluminum with beveled edges to receive sealant cap after installation. Fasteners shall be non-corrosive, fastened at 12 inches O.C. max. Cut termination bars at inside and outside corners, do not bend around corners.
- D. Reglet Terminations Metal counter flashings shall be as specified in Section 07 6000.
- E. Vapor Barrier Provide Mfr. recommended vapor barrier over deck.
 - 1. Prepare surfaces and prime per Mfr. recommendations.
 - 2. At metal deck surfaces, install 5/8-inch DensDeck prior to installation of vapor barrier. Use stainless steel fasteners at all locations receiving DensDeck.
 - 3. Penetrations through vapor barrier are to be sealed.

Part 3 Execution

3.01 Examination

- A. Cover all equipment, tanks, vehicles, etc. at the interior of the building to protect from damage or falling debris during installation. Determine any conflicts with conduit, piping, lights, etc. mounted to the underside of the deck to ensure that these components are not damaged during installation.
- B. Verify that surfaces and site conditions are ready to receive work.
- C. Verify deck is supported and secure.
- D. Verify deck is clean and smooth, free of depressions, waves, or projections.
- E. Verify deck surfaces are dry and free of snow or ice.
- F. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set.

3.02 Preparation

A. Concrete Deck: Fill surface honeycomb and variations with latex filler in concrete deck, as required by roofing manufacturer to establish suitable, acceptable insulation base surface. Infill roof openings were equipment is to be removed, as may be called for on the Drawings.

B. Metal Deck: Infill holes where equipment has been removed as may be called for on the Drawings and where existing deck is found to be deteriorated and requires replacement. Infill material shall be new metal deck as specified in Section 05 500, Metal Fabrications.

3.03 Vapor Retarder Application

- A. Apply vapor retarder to precast concrete deck surface with adhesive in accordance with manufacturer's instructions.
- B. Extend vapor retarder up and over parapet walls and curbing.
- C. Lap flexible flashing over vapor barrier of wall construction to provide continuity of vapor barrier seal. Coordinate with Section 07 100, Dampproofing and Waterproofing.

3.04 Insulation Application

- A. Concrete Roof Deck:
 - 1. Apply adhesive to concrete deck in accordance with adhesive and insulation manufacturer's instructions. Embed insulation into adhesive with full contact.
 - 2. If multiple layers of insulation are used over the concrete deck, apply adhesive to the top surface of insulation. Embed the second layer of insulation into adhesive, with joints staggered minimum 6 inch from joints of first layer.
 - 3. Adhesive used shall be selected and installed in accordance with the manufacturer's requirements based on the insulation used and an FM I-90 uplift requirement.
 - 4. Insulation glued to the concrete deck.
 - 5. Outdoor temperatures must be 35 degrees and rising for adhesive installation.
 - 6. Store adhesive in 60 degree to 80 degree temperature until ready to use.
 - 7. Adhesive shall be 60 degrees to 80 degrees when installed.
 - 8. Adhesive shall be installed in accordance with the manufacturer's requirements based on the insulation used and an I-90 uplift requirement.
 - 9. Verify proper mixing prior to applying adhesive to deck, no marbling in the adhesive is allowed.
- E. Do not allow bead of adhesive to "skin over" before installing insulation board.
 - 1. Pull test shall be required each day to verify applicability for that day.
 - 2. Insulation boards shall be weighted down after placement until adhesive is set to insure full continuous contact.
- B. Metal Deck:
 - 1. Mechanically fasten insulation to metal deck to meet uplift requirements specified.
 - 2. Fasteners shall be installed in accordance with the manufacturer's requirements based on the insulation used and an FM 1-90 uplift requirement.

- 3. Where multiple layers of insulation are used, stagger upper layer(s) joints minimum 6 inch from joints of adjacent under layer joints.
- C. Insulation Installation:
 - 1. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
 - 2. Where tapered boards are provided for general roof surface slope, utilize a minimum slope of 1/8 inch per foot from the high side to the low side for positive drainage. Use 1/2 inch per foot on all cants, saddles, crickets.
 - 3. Apply no more insulation than can be covered with membrane in same day.

3.05 Membrane Installation

- A. Apply membrane in accordance with manufacturer's instructions.
- B. Place membrane in final position and fold back per manufacturer's instructions. Place membrane so that the seams shed water. Remove dusting agent and dirt from backside of membrane.
- C. Apply adhesive at a rate as recommended by the Manufacturer.
- D. Test adhesive for Readiness (Touch-Push Test).
- E. Roll out membrane, free from air pockets, wrinkles, or tears. Firmly press sheet into place without stretching.
- F. Overlap edges and ends and seal in accordance with the manufacturer's requirements.
- G. Shingle joints on sloped substrate in direction of drainage.
- H. Extend membrane up a minimum of 8 inches onto vertical surfaces.
- I. Seal membrane around roof penetrations.

3.06 Flashings and Accessories

- A. Fabricate custom roofing expansion joints to replace existing joints as specified and shown on the Drawings.
- B. Seal flashings and flanges of items penetrating membrane.
- C. Equipment drains, gas lines and pipe penetrations; conduits, vents etc. shall be supported and flashed per the roofing manufacturer's warranty requirements, as a part of this Work.
- D. Pipe Supports: On roof pipe supports shall be DuraBlok or equal, non-penetrating base supports.
- E. Include extra thickness of roofing material under pipe supports. Pieces shall be fully adhered to membrane underneath.
- F. Roof Walk Pads: Minimum 30 inch x 30 inch, black cured polymer walkway pad with raised, non-slip profile, compatible with approved EPDM roofing membrane. Space pads with maximum 3 inch gap between pad edges to promote drainage.

3.07 Field Quality Control

- A. Section 01 4500, Quality Control: Field inspection and testing.
- B. Manufacturer shall inspect the completed roof for proper installation and the Engineer shall be notified a minimum of 48 hours in advance of the date of the inspection.
- C. Correct identified defects or irregularities.

3.08 Cleaning

- A. In areas where finished surfaces are soiled by Work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- B. Repair or replace defaced or disfigured finishes caused by work of this section.

3.09 Protection of Finished Work

- A. Protect building surfaces against damage from roofing work.
- B. Where traffic must continue over finished roof membrane, protect surfaces.
- C. Protect installation from damage until acceptance by OWNER.

End of Section

Section 07 5600 Cold Fluid Applied Roofing

Part 1 General

1.01 Scope of Work

- A. Protective coating for the roof of the Primary Sludge Pump Station as shown on the Drawings.
- B. Roof coating preparation including preparation of concrete deck and substrate to receive fluid-applied waterproofing roofing.
- C. Application of fluid-applied waterproofing roof membrane and flashings to prepared existing concrete deck.

1.02 Submittals for Review

- A. Prepare and submit the following in accordance with "Conditions of the Contract" and Section 01 3300, Submittals Procedures:
- B. Product Data: Submit manufacturer's product data, with complete general and specific installation instructions, recommendations, and limitations.
- C. Product Samples: Submit representative samples of specified materials.
- D. Material Certificates: Submit certificate(s) signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements. Submit certification that system and components, and protection materials are supplied by a single-source manufacturer.
- E. Contractor Certificate: At time of bid, submit written certification that installer has current Approved Applicator status with material manufacturer.
- F. NSF Standard 61 Certification: Submit Official NSF Listing for standard roof coating system confirming that product conforms to the requirements of NSF Standard 61 Drinking Water System Components Health Effects.

1.03 Quality Assurance

- A. Installer Qualifications:
 - 1. Installing company should have at least three (3) years' experience in work of the type required by this section, who can comply with manufacturer's warranty requirements, and who is an Approved Applicator as determined by system manufacturer.
- B. Manufacturer Qualifications:
 - 1. Waterproofing and all accessory products shall be provided by a single manufacturer with a minimum of 20 years' experience in the direct production and sales of specified waterproofing systems.
 - 2. Manufacturer shall be capable of providing field service representation during construction, approving an acceptable installer, recommending appropriate installation methods, and conducting a final inspection of the waterproofing system applied.

- C. Pre-Installation Conference:
 - 1. A pre-installation conference shall be held prior to commencement of field installation to establish procedures to maintain required working conditions and to coordinate this work with related and adjacent work.
 - 2. Verify that final waterproofing and waterstop details comply with waterproofing manufacturer's current installation requirements and recommendations.
 - 3. Pre-con meeting attendees should include representatives for OWNER, ENGINEER, and CONTRACTOR.
- D. Materials:
 - 1. Obtain waterproofing roofing materials from a single manufacturer to assure material compatibility.
- E. Roofing Inspector Qualifications: A technical representative of the manufacturer (not engaged in the sale of products) experienced in the installation and maintenance of the specified roofing system, shall be engaged to provide observation services by the CONTRACTOR to review the installation of the waterproofing roofing system. This observer shall be qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
 - 1. An authorized full-time technical employee of the manufacturer.
 - 2. An independent party certified as a Registered Roof Observer by the IIBEC, retained by the CONTRACTOR or the Manufacturer and approved by the Manufacturer.

1.04 Product Delivery, Storage and Handling

- A. Delivery, Storage and Handling:
 - 1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, ate of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
 - 2. Handle and store roofing materials, and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
 - 3. Protect materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting.

1.05 **Project Conditions**

- A. Protect building, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from roofing operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

- C. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit Work to proceed without water entering into existing roofing system or building.
 - 1. Store all materials prior to application at temperatures between 60 and 90 degrees Fahrenheit.
 - 2. Apply coatings within range of ambient and substrate temperatures recommended by manufacturer. Do not apply materials when air temperature is below 40 or above 85 degrees Fahrenheit, providing the substrate is a minimum of 5 degrees Fahrenheit above the dew point.
 - 3. Do not apply roofing in snow, rain, fog, or mist.
- D. Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1.06 Warranty

- A. Manufacturer: Manufacturer's standard warranty form, covering work of this Section, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within warranty period.
 - 1. Warranty Period: 20 years from date of completion.
- B. Installer Warranty: Installer's warranty signed by Installer, covering the Work of this Section on form acceptable to Roofing Manufacturer and Owner.
 - 1. Warranty Period: 2 years from date of completion.

Part 2 Products

2.01 Acceptable Manufacturer

- A. Tremco AlphaGuard PUMA (80 mils)
- B. Substitutions, Materials and Equipment: Product substitutions permitted in accordance with Section 01 2513, Substitution Procedures.

2.02 Performance Requirements

- A. General: Provide recoated roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency in accordance with ANSI/FM 4474, UL 580, or UL 1897, and to resist uplift pressures.

- 1. All Zones (Corner, Perimeter, and Field-of-Roof) Uplift Pressures: As recommended by Mfr.
- D. Flashings: Provide base flashings, perimeter flashings, detail flashings and component materials that comply with requirements and recommendations of the following:
 - 1. Roof system manufacturer's construction details and recommendations.
 - 2. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations.
 - 3. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details.
- E. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

2.03 Materials

- A. General: Roofing materials recommended by roofing system manufacturer for intended use and compatible with components of existing membrane roofing system.
- B. Temporary Roofing Materials: Selection of materials and design of temporary roofing is responsibility of Contractor.
- C. General: Provide adhesive and sealant materials recommended by roofing manufacturer for intended use and compatible with roofing materials.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

2.04 Fluid Applied Roofing Membrane

- A. Polyurethane Elastomeric Fluid-Applied System: Two-coat fluid-applied roofing membrane formulated for application over prepared roof substrate.
 - 1. Polyurethane-modified methyl methacrylate reinforced roof coating system base coat, two-part moisture-curing for use with a compatible top coat.
 - 2. Basis of design product: Tremco, AlphaGuard PUMA Base Coat.
 - 3. Combustion Characteristics, UL790: Class A, for two-coat system.
 - 4. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
 - 5. Tensile Strength, ASTM D5147: 177 lbf/in (31.1 N/mm).
 - 6. Elongation, Reinforced, ASTM D5147: 40 percent.
 - 7. Crack Bridging, ASTM D5147: Pass- 2 mm.
 - 8. Hardness, Shore A, minimum, ASTM D2240: 93.
 - 9. Minimum Thickness, Base Coat: 40 mils (1 L/m2) plus 40 wet mils (1 L/m2)

- B. Polyurethane-modified methyl methacrylate roof coating system top coat, twocomponent 0 VOC, UV resistant, for application over compatible base coat.
 - 1. Basis of design product: Tremco, AlphaGuard PUMA Top Coat.
 - 2. Combustion Characteristics, UL 790: Class A, for two-coat system.
 - 3. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
 - 4. Tensile Strength, ASTM D5147: 177 lbf/in (31.1N/mm).
 - 5. Elongation, Reinforced, ASTM D5147: 40 percent.
 - 6. Crack Bridging, ASTM D5147: Pass, 2 mm.
 - 7. Hardness, Shore A, minimum, ASTM D2240: 93.
 - 8. Solar Reflectance Index (SRI), minimum, ASTM E1980: 95.
 - 9. Minimum Thickness: 20 mils (0.50 mm) wet over cured base coat.

2.05 Auxiliary Roofing Materials

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with existing roofing system and fluid-applied roofing system.
- B. Concrete Primer:
 - 1. Primer, Methyl Methacrylate: Two-component primer for concrete and metal substrates for application of PUMA coatings.
 - 2. Basis of design product: Tremco, AlphaGuard PUMA Primer 107.
 - 3. Coverage Rate: 1 gal/100 sq. ft (16 mils) (0.40 mm) wet.
- C. Metal Surface Primer:
 - 1. Primer, Methyl Methacrylate: Two-component primer for concrete and metal substrates for application of PUMA coatings.
 - 2. Basis of design product: Tremco, AlphaGuard PUMA Primer 107.
 - 3. Coverage Rate: 1 gal/100 sq. ft (16 mils) (0.40 mm) wet.
- D. Reinforcing Fabric:
 - 1. Polyester Reinforcing and Protection Fabric: 100 percent stitch-bonded mildewresistant polyester fabric intended for reinforcement of compatible fluid-applied membranes and flashings and as a protection layer under pavers or stone aggregates.
 - 2. Basis of design product: Tremco, Permafab.
 - 3. Tensile Strength, Minimum, ASTM D1682: 50 lbf (23 kg) avg.
 - 4. Elongation, Minimum, ASTM D1682: 60 percent.
 - 5. Tear Strength, Minimum, ASTM D1117: 16 lbf (7.3 kg) avg..
 - 6. Weight: 3 oz./sq. yd (102 g/sq. m).

- E. Joint Sealants:
 - 1. Joint Sealant, Polyurethane: ASTM C920, Type S, Grade NS, Class 50 singlecomponent moisture curing sealant, formulated for compatibility and use in dynamic and static joints; paintable.
 - 2. Basis of design product: Tremco, TremSEAL Pro.
 - 3. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 40 g/L.
 - 4. Hardness, Shore A, ASTM C661: 40.
 - 5. Adhesion to Concrete, ASTM C794: 35 pli.
 - 6. Tensile Strength, ASTM D412: 350 psi (2413 kPa).
 - 7. Color: Closest match to substrate.

2.06 Walking Surface Material

- A. Polyurethane-modified methyl methacrylate top coat slip resistant: second top coat, with broadcast slip resistant aggregate.
 - 1. Basis of design product: Tremco, AlphaGuard PUMA Top Coat Slip Resistant.
 - 2. Minimum Thickness: 16 wet mils, (0.40 mm) wet; over cured top coat.
 - 3. Silica Sand Aggregate: 20 to 30 lb/100 sq. ft..
 - 4. Color: As selected from manufacturer's standard colors.

Part 3 Execution

3.01 Examination

- A. Examine roofing substrates, with Installer present, for compliance with requirements and for other conditions affecting application and performance of fluid-applied roofing.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
 - 2. Verify that substrates are sound, visibly dry and free of moisture.
 - 3. Verify that substrates have adequately cured to enable proper bond with base coat.
 - 4. Application of fluid-applied roofing indicates acceptance of surfaces and conditions.

3.02 Preparation, General

- A. Protect existing roofing system that is indicated not to receive fluid-applied roofing, and adjacent portions of building and building equipment.
- B. Remove existing equipment on roof necessary to ensure a continuous roof and flashing system. Denote on drawings the metal hatches, and conduit line sitting on concrete deck.
- C. Shut down air intake equipment in the vicinity of the Work in coordination with the Owner. Cover air intake louvers before proceeding with coating work that could affect indoor air quality or activate smoke detectors in ductwork.

- 1. Verify that rooftop utilities and service piping affected by the Work have been shut off before commencing Work.
- 2. Prevent dust, vapors, gases, and odors from entering occupied building during roof installation. When shutting down or blocking air intakes, provide makeup air or additional intake air from sources away from the work area.

3.03 Concrete Deck Preparation

- A. Concrete Deck Preparation, General: Repair, clean, and prepare concrete to sound condition free of grease, oils, coatings, dust, curing compounds and other contaminants.
- B. Testing: Following surface preparation, perform testing to verify concrete substrate is adequate prepared to receive fluid-applied roofing in accordance with manufacturer's written instructions.
 - 1. Pull Test: Verify that the cleaned surface pulls concrete when tested per ASTM D 4541.
 - 2. Moisture Test: Verify that concrete substrate is visibly dry and free of moisture when tested by plastic sheet method per ASTM D 4263.

3.04 Preparation of Existing Flashings

- A. Existing Flashing and Detail Preparation: Repair flashings, copings, and other roof-related sheet metal and trim elements. Reseal joints, replace loose or missing fasteners, and replace components that cannot be repaired to weathertight and like-new condition.
 - 1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris, and prepare for application of re-coating system.

3.05 Fluid Applied Flashing Application

- A. Surface Priming: Prime flashing substrate with specified primer at rate indicated in Part 2 product listing and allow primer to dry.
- B. Fluid-Applied Flashing and Detail Base Coat Application: Complete base coat and fabric reinforcement at parapets, curbs, penetrations, and drains prior to application of field of fluid-applied membrane. Apply flashing base coat in accordance with manufacturer's written instructions.
 - 1. Apply base coat on prepared and primed surfaces and spread coating evenly. Extend coating minimum of 8 inches or 3 brick courses (200 mm) up vertical surfaces and 4 inches (100 mm) onto horizontal surfaces.
 - 2. Back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 - 3. Fabric Reinforcement: Place fabric reinforcement onto wet base coat. Lap adjacent flashing pieces of fabric minimum 3 inches along edges and 6 inches at end laps.
 - a. Apply second base coat over installed fabric reinforcement and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.

5. Following curing of base coat and prior to application of topcoat, sand raised or exposed edges of fabric reinforcement.

3.06 Fluid Applied Membrane Application

- A. Concrete Repair: Patch concrete surface with concrete repair resin products compatible with fluid-applied membrane roofing system.
- B. Surface Priming: Prime flashing substrate with specified primer at rate indicated in Part 2 product listing and allow primer to dry.
- C. Base Coat: Apply base coat to field of membrane in accordance with manufacturer's written instructions. Apply base coat on prepared and primed surfaces and spread coating evenly.
 - 1. Apply base coat on prepared and primed surfaces and spread coating evenly. Extend coating minimum of 8 inches (200 mm) up vertical surfaces and 4 inches (100 mm) onto horizontal surfaces.
 - 2. Back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 - 3. Apply first base coat over prepared concrete deck and flashings and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify thickness as work progresses.
 - a. Apply second base coat over first base coat layer and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 - 4. Allow base coat to cure prior to application of topcoat.
 - 5. Following curing of base coat and prior to application of topcoat, sand raised or exposed edges of fabric reinforcement.
- D. Topcoat: Apply topcoat uniformly in a complete installation to field of roof and flashings.
 - 1. Prime base coat prior to application of topcoat if topcoat is not applied within 72 hours of the base coat application, using manufacturer's recommended primer.
 - 2. Apply topcoat to flashings extending coating up vertical surfaces and out onto horizontal surfaces 4 inches. Install topcoat over field base coat and spread coating evenly.
 - 3. Apply topcoat and back roll to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
 - 4. Avoid foot traffic on new fluid-applied membrane for a minimum of 24 hours.
- E. Slip-Resistant Surfacing Topcoat: Apply second topcoat following application and curing of topcoat. Locate as indicated, or as directed by Owner.

- 1. Prime first topcoat prior to application of walkway topcoat if walkway topcoat is not applied within 72 hours of the first topcoat application, using manufacturer's recommended primer.
- 2. Apply slip resistant topcoat layer and back roll to balance of coated roof area to achieve not less than minimum coating thickness indicated in Part 2 product listing unless greater thickness is recommended by manufacturer. Verify application thickness as work progresses.
- 3. Broadcast Slip-Resistant Topcoat Aggregate in wet topcoat at rate indicated in Part 2 product listing or as otherwise recommended by coating manufacturer.
 - a. Back roll sand and topcoat creating even dispersal of sand.

3.07 Field Quality Control

- A. Roofing Inspector: Owner will engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.
- B. Roof Inspection: Contractor shall engage roofing system manufacturer's technical personnel to inspect roofing installation and submit report to the Architect. Notify Architect or Owner 48 hours in advance of dates and times of inspections. Inspect work as follows:
 - 1. Upon completion of preparation of first component of work, prior to application of re-coating materials.
 - 2. Following application of re-coating to flashings and application of base coat to field of roof.
 - 3. Upon completion of re-coating but prior to re-installation of other roofing components.
- C. Repair fluid-applied membrane where test inspections indicate that they do not comply with specified requirements.
- D. Arrange for additional inspections, at Contractor's expense, to verify compliance of replaced or additional work with specified requirements.

3.08 Protecting and Cleaning

- A. Protect roofing from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove coatings that do not comply with requirements, repair substrates, and reapply coatings.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

End of Section

Section 07 6000 Flashing and Sheet Metal

Part 1 General

1.01 Scope of Work

- A. This section includes furnishing and installing:
 - 1. Sill flashings, drip edges and formed metal trim pieces not specified elsewhere.
 - 2. Metal edge and preformed roof flashings.
 - 3. Counterflashings over base flashings.
 - 4. Metal Parapet Caps.

1.02 Related Work Specified Elsewhere

A. Section 07 9200: Joint Sealers

1.03 Standard References

- A. AISI (American Iron and Steel Institute) Stainless Steel Uses in Architecture.
- B. ASTM A167 Stainless and Heat Resisting Chromium Nickel Steel Plate.
- C. ASTM B32 Solder Metal.
- D. ASTM B209 Aluminum and Alloy Sheet and Plate.
- E. ASTM B370 Copper Sheet and Strip for Building Construction.
- F. ASTM D4586 Asphalt Roof Cement, Asbestos Free.
- G. CDA (Copper Development Association) Contemporary Copper, A Handbook of Sheet Copper Fundamentals, Design, Details and Specifications.
- H. FS O F 506 Flux, Soldering, Paste and Liquid.
- I. NRCA (National Roofing Contractors Association) Roofing Manual.
- J. SMACNA Architectural Sheet Metal Manual.

1.04 Submittals

- A. Submit in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Submit two samples 6-inch x 6-inch in size illustrating metal finish color for each type for flashing to be provided

1.05 Quality Assurance

- A. Perform work in accordance with AISI, CDA, NRCA and SMACNA standard details and requirements. Several SMACNA standard documents and fabrications are referred to, in this Work. Maintain one copy of each document/ cut sheet on site. Where not specifically detailed or specified, comply with SMACNA's "Architectural Sheet Metal Manual". Conform to dimensions and profiles recommended unless more stringent requirements are indicated.
- B. Maintain one copy of each document on site.

1.06 Qualifications

A. Fabricator and Installer: Company specializing in sheet metal flashing work on Historical Structures with at least five (5) years' documented experience.

1.07 Delivery, Handling and Storage

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials which may cause discoloration or staining.

1.08 Warranty

- A. Products shall be warranted to be free of defects in material and workmanship for a period of five (5) years from date of shipment.
- B. Product liability is limited to the repair or replacement of furnished materials, provided printed installation instructions have been followed. Manufacturer shall provide, at no additional charge to OWNER, a 20-year finish warranty against peeling, chalking, fading, checking and crazing, commencing upon the date of substantial completion. No other warranties either expressed or implied are acceptable unless so stated in writing.

1.09 Coordination

- A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation, including installation of roofing materials. Ensure best possible weather resistance and durability of work and protection of materials and finishes.
- B. Convene one week prior to commencing work of this section, under provisions of Section 01 3119, Project Meetings.

Part 2 Products

2.01 Manufacturers

A. Fabrications shall be factory fabricated to the extent possible. CONTRACTOR may elect to provide field fabricated copings and flashings as long as the metals are as specified and fabricated as called for in this Section.

- B. Manufacturer shall note flashing configurations as required on the Drawings and Contractor shall provide existing field dimensions for fabrications as required for the Work.
- C. Provide product configurations by one of the following:
 - 1. IMETCO, Inc.
 - 2. PAC-CLAD Peterson
 - 3. W.P. Hickman

2.02 Sheet Materials

- A. Copper: ASTM B370, cold rolled 16 oz/sq ft.
- B. Galvanized Steel Sheet: Mill phosphatized, minimized spangle, zinc coating designation G90 per ASTM A 525.
- C. Galvanized Steel Gages: Metal gages shall be as specified below. If a fabrication is required <u>that is not listed</u> below, Contractor shall follow minimum SMACNA galvanized steel gage recommendations for that item. Unless noted otherwise on the Drawings, use minimum 22 gage for all items except:
 - 1. Use 24 gage for continuous cleats, reglets and counter flashings.
 - 2. Use 24 gage for gravel stop/fascias up to 5 inches high (over 5 inches use 22 gage.)
 - 3. Use 24 gage for rain gutter girth up to 20 inches; for larger girth, follow SMACNA recommended minimum gages.
 - 4. Use 24 gage for downspouts; hanger fabrications shall be minimum 1/16" x 1" flat stock, color to match downspouts.

2.03 Accessories

- A. Fasteners: Same material and finish as flashing metal (unless noted otherwise on the Drawings), with soft neoprene washers.
- B. Protective Backing Paint: Specified in Section 09 9000.
- C. Sealant: Specified in Section 07 9000.
- D. Bedding Compound: Type appropriate for substrate.
- E. Plastic Cement: ASTM D4586, asbestos free.

2.04 Fabrication

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats of same material as sheet, interlockable with sheet.
- C. Form pieces in longest possible lengths; profiles as shown on the Drawings.

- D. Hem exposed edges on underside 1/4 inch (6 mm); miter and seam corners.
- E. Pretin edges of copper sheet. Solder shop formed metal joints. After soldering, remove flux. Wipe and wash solder joints clean. Weather seal joints.
- F. Fabricate corners from one piece with minimum 6 inch long legs; miter joint shall be watertight welded or standing seal construction; sealing with only sealant is not acceptable.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- H. Field fabricated copings and expansion joints shall have standing seams and continuous cleat securement in accordance with SMACNA recommendations. Lap seams and butt joints in field fabricated copings and flashings are not acceptable.
- I. Gutters and downspouts shall be of same cross-sectional size as the existing installation, fabricated in accordance with SMACNA standards. Re-use existing splash blocks at grade. Provide new hangers to match existing for gutter support. Gutter style shall match existing profile and size.

2.05 Finish

- A. Polyvinylidene Fluoride Finish: Factory-applied baked-on polyvinylidene fluoride resin finish containing not less than 70% Kynar 500 or Hylar 5000 resin, with minimum total dry film thickness of 1.0 mil (0.2 mil primer and 0.8 mil finish), in standard color as selected per approved samples.
- B. Back paint concealed metal surfaces as specified for dissimilar metal protection on aluminum flashings and fabrications.

Part 3 Execution

3.01 Examination

- A. Verify roof openings, pipes, sleeves, ducts, or vents through roof are solidly set.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 Preparation

A. Install starter and edge strips, and cleats before starting installation.

3.03 Installation

- A. Conform to drawing details for steep roofing included in the NRCA manual.
- B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- C. Apply plastic cement compound between metal flashings and felt flashings.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

- E. Seal metal joints watertight.
- F. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

3.04 Field Quality Control

- A. Field inspection will be performed under provisions of Section 01 4500, Quality Control.
- B. Inspection will involve ENGINEER observation of work during installation to ascertain compliance with specified requirements.

End of Section

Section 07 7233 Roof Hatches

Part 1 General

1.01 Section Includes

A. Prefabricated roof hatches, with integral support curbs, operable hardware, safety railings and counterflashings.

1.02 Related Sections

- A. Section 06 1053.16: Wood Blocking and Curbing
- B. Section 07 6000: Flashing and Sheet Metal
- C. Section 08 7100: Door Hardware
- D. Section 09 9000: Painting and Coating

1.03 References

- A. FM Roof Assembly Classifications.
- B. UL Fire Hazard Classifications.

1.04 Submittals for Review

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data on unit construction, sizes, configuration, jointing methods and locations when applicable, and attachment method.
- C. Manufacturer's Installation Instructions: Indicate special installation criteria, interface with adjacent components.

1.05 Warranty

- A. Refer to Section 01 7700, Closeout Procedures with regard to guarantee period.
- B. Hatches shall be covered by the manufacturer's 5-year warranty against defect on materials and workmanship.

Part 2 Products

2.01 Roof Hatch

- A. Manufacturers:
 - 1. Bilco Company.
 - 2. Milcor.
- B. Substitutions, Materials and Equipment: Product substitutions permitted in accordance with Section 01 2513, Substitution Procedures.

2.02 General

- A. Hatches shall be designed to carry a minimum of 40 pounds per square foot live load on the covers without deflection of more than 1/240 of the span.
- B. Integral Steel Curb: 11-gage aluminum with 1-inch rigid insulation; integral cap flashing to receive roof flashing; extended flange for mounting.

- C. Cover and liner shall be min. 18 gage aluminum with an aluminum frame.
- D. Hatches shall have manufacturer's standard thermoplastic rubber gasketing to ensure weathertightness.
- E. Hardware shall be type 316 stainless steel:
 - 1. Compression spring operator and shock absorbers;
 - 2. Steel manual pull handle for interior and exterior operation;
 - 3. Steel hold open arm with vinyl covered grip handle for easy release,
 - 4. Padlock hasp, inside and outside.
 - 5. Hinges: Heavy duty pintle type.
- F. Accessories:
 - 1. Telescoping safety post shall be provided at the ladder access hatch to the roof. The safety post shall be the type that can be extended above the hatch cover when the hatch is open to assist personnel, and retractable to original position for closing hatch. Safety post mounts to the center of the ladder. Device shall be constructed of type 304 stainless steel.

2.03 Fabrication

- A. Fabricate components free of visual distortion or defects. Fully welded corners and joints to ensure weathertightness.
- B. Provide for removal of condensation occurring within components or assembly.
- C. Fit components for weather tight assembly.
- D. Steel hatches shall receive factory applied powder coat with color choice as selected from manufacturer's standard selection.

Part 3 Execution

3.01 Installation

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate with installation of roofing system and related flashings for weather tight installation.
- C. Verify installation of deck edge flashing pieces prior to installation of roof hatches.
- D. Apply bituminous paint on surfaces of units in contact with cementitious materials or dissimilar metals.
- E. Adjust hinges for smooth operation.
- F. Telescoping safety hatch shall be attached to the ladder, centered between the ladder rails.

End of Section

Section 07 9200 Joint Sealants

Part 1 General

1.01 Section Includes

- A. CONTRACTOR shall furnish materials, equipment and perform all work to complete installation of exterior caulking including, but not necessarily limited to, the following:
 - 1. Joints between exterior metal frames and adjacent materials.
 - 2. Exterior joints at doors, sash, and other openings to provide air and weathertight construction.
 - 3. Interior joints at door frames, sash and adjacent construction and other locations, as shown on the Drawings.
- B. Preparing substrate surfaces.
- C. Sealant and joint backing.

1.02 Related Sections

- A. Section 03 3000: Cast-in-Place Concrete
- B. Section 03 4133: Pre-Cast, Pre-Stressed Concrete
- C. Section 04 2000: Unit Masonry
- D. Section 08 1213.53: Custom Steel Frames

1.03 References

- A. ASTM C804 Use of Solvent-Release Type Sealants.
- B. ASTM C920 Elastomeric Joint Sealants.
- C. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.
- D. SWRI (Sealant, Waterproofing and Restoration Institute) -Sealant and Caulking Guide Specification.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations and color availability.
- C. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.05 Quality Assurance

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.06 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.
- B. Applicator: Company specializing in performing the work of this section with minimum three years' experience.

1.07 Environmental Requirements

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 Coordination

- A. Coordinate work under provisions of Section 01 3119, Project Meetings.
- B. Coordinate the work with other Sections referencing this Section.

1.09 Warranty

- A. Provide five-year warranty under provisions of Section 01 7700, Closeout Procedures.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve weathertight seal, and exhibit loss of adhesion or cohesion, or do not cure.

Part 2 Products

2.01 Sealants

- A. Polyurethane Sealant: ASTM C920, Grade NS, Type M, Class 25, two component, chemical curing, non-staining, non-bleeding, capable of constant water immersion, non-sagging type; color to match adjacent surfaces; Sonolastic NP-2 manufactured by Sonneborn Building Products; Dynatrol II, manufactured by Pecora Corporation, Bostik Chem-Calk 505 or Dymeric 240 FC by Tremco.
 - 1. Elongation Capability: Minimum 25 percent.
 - 2. Service Temperature Range: -40 to 180 degrees Fahrenheit (-40 to 82 degrees Celsius)
 - 3. Shore A Hardness (After aging): 35
- B. Polyurethane Sealant, Self-Leveling: ASTM C920, Grade P, Type M, Class 25, Use T, two component, chemical curing, non-staining, non-bleeding, capable of water immersion; color to match adjacent surfaces; Sonolastic Paving Joint Sealant, manufactured by Sonneborn Building Products; Pecora Urexpan NR-200, manufactured by Pecora Corporation.
 - 1. Elongation Capability: Minimum 25 percent.
 - 2. Service Temperature Range: -40 to 150 degrees Fahrenheit (-40 to 65 degrees Celsius)
 - 3. Shore A Hardness: 30

- C. Polysulfide Sealant: Federal Specification TT-S-00227E, Type II, and ASTM C920, Grade NS, Type M, Class 25 use NT, M, A, and G; two component, non-sag polysulfide rubber sealant. Synthacalk GC2+, manufactured by Pecora Corporation; Two-part Polysulfide, manufactured by Sonneborn Building Products, or other approved equal. Polysulfide shall be used where indicated on the Contract Drawings for a specific location.
- D. Polyurethane sealants shall be used as the standard sealant on this project for general application throughout the work unless a particular sealant is indicated on the Contract Drawings for a specific location.

2.02 Accessories

- A. Primer: Non-staining type, as may be recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round, closed cell polyethylene foam rod; sized to compress 25 percent when inserted in the joint; "Kool-Rod" by W.R. Meadows or equal.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

Part 3 Execution

3.01 Examination

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 Preparation

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.
- B. Clean and prime, if recommended, joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with ASTM C804 for solvent release sealants.

3.03 Installation

- A. Install sealant in accordance with manufacturer's instructions.
- B. Measure joint dimensions and size materials to achieve required 2:1 width/depth ratios.
- C. Install joint backing to achieve a joint depth dimension no greater than 1/3 of the joint width.
- D. Install bond breaker where joint backing is not used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

3.04 Cleaning

- A. Clean work under provisions of 01 7700, Closeout Procedures.
- B. Clean adjacent soiled surfaces.

3.05 Protection of Finished Work

- A. Protect finished installation under provisions of Section 01 5000, Temporary Facilities and Controls.
- B. Protect sealants until cured.

End of Section

Division 08 Openings

Section 08 1213.53 Custom Steel Frames

Part 1 General

1.01 Section Includes

A. Rated and non-rated galvanized, reinforced steel frames for hollow metal doors.

1.02 Products Furnished but Not Installed Under This Section

A. Section 04 2000, Concrete Unit Masonry: Placement of anchors into wall construction.

1.03 Related Sections

- A. Section 04 0513: Mortar and Masonry Grout
- B. Section 08 1313.53: Custom Steel Doors
- C. Section 08 7100: Door Hardware
- D. Section 08 8000: Glazing
- E. Section 09 9000: Painting and Coating

1.04 References

- A. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- B. DHI Door Hardware Institute: The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.
- C. HMMA 802 Manufacturing of Hollow Metal Doors and Frames.
- D. HMMA 820 Hollow Metal Frames.
- E. HMMA 830 Hardware Preparation and Locations for Hollow Metal Doors and Frames.
- F. HMMA 840 Installation and Storage of Hollow Metal Doors and Frames.
- G. HMMA 850 Fire Rated Hollow Metal Doors and Frames.
- H. NFPA 80 Fire Doors and Windows.
- I. NFPA 252 Fire Tests for Door Assemblies.
- J. UL 10B Fire Tests of Door Assemblies.

1.05 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate frame elevations, reinforcement, construction and finish. Provide details for removable hollow metal transom at transom panel.
- C. Shop Drawings: Indicate the following:
 - 1. Details of doors including vertical and horizontal edge details.
 - 2. Frame details for each frame type including dimensioned profiles.
 - 3. Details and locations of reinforcement and preparations for hardware.
 - 4. Details of each different wall opening condition.
 - 5. Details of anchorages, accessories, joints, and connections.

1.06 Quality Assurance

- A. Conform to requirements of HMMA 802, HMMA 820, HMMA 830, HMMA 840, HMMA 850, SDI 100, ANSI A117.1 and ANSI A151.1.
- B. A physical label or approved marking shall be affixed to fire door rated frames at an authorized facility as evidence of compliance with procedures of the labeling agency.

1.07 Qualifications

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

1.08 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site in accordance with the manufacturer's instructions.
- B. Protect frames with resilient packaging sealed with heat shrunk plastic.
- C. Break seal on-site to permit ventilation. If moisture appears under the shipping wrapper, remove wrapper, vent to dry and recover, allowing air to circulate around frames.
- D. Store frames upright, under cover, on 4-inch wood sills set on floors in a manner to prevent rust and damage. Provide a 1/4-inch space between frames to promote air circulation.

1.09 Field Measurements

A. Verify that field measurements are as indicated on the shop drawings.

1.10 Coordination

- A. Coordinate work under provisions of Section 01 6000, Product Requirements.
- B. Coordinate the work with frame opening construction, door and hardware installation.

Part 2 Products

2.01 Frame Manufacturers

- A. CECO
- B. Substitutions: Under provisions of the Specifications.
 - 1. Substitutions must meet the gage and galvanizing specification requirements.
 - 2. Frames shall be from the same manufacturer as the hollow metal doors.

2.02 Frames

- A. Steel: G90 Galvanized sheet in accordance with ASTM A653.
- B. Frames: 14 gage thick material, core thickness.

2.03 Accessories

A. Silencers: Resilient rubber fitted into drilled hole are required on all interior frames.

- B. Bituminous Coating: Fibered asphalt emulsion.
- C. Primer: Zinc chromate.
- D. Masonry jamb anchors shall be galvanized strap anchors; wire anchors are not permitted. Anchors shall be perforated to aid in the mortaring solid of frames.
 - 1. UL requirements indicate the strap anchors must be welded in place.
 - a. Coordinate placement with masonry coursing.
 - b. Touch-up galvanized coating damaged from welding prior to backcoating of frame.
- E. Where frames are to be installed in concrete walls provide countersunk expansion anchor bolts (4 per jamb) to secure frame.
 - 1. Anchor bolt heads shall be glazed over with epoxy, flush and smooth with frame surface, primed and finish painted to match frame.
- F. Provide adjustable jamb base anchors for each frame.

2.04 Fabrication

- A. Fabricate frames to HMMA 802 and 820, style and configuration to suit doors specified in Section 08 1313.53, Custom Steel Doors.
- B. Fabricate frames with 2-inch jamb face and 2-inch head (unless noted otherwise on the Drawings); frames shall be set-up and arc welded with corner welds ground smooth.
- C. Mortise all exterior frames for 2 pairs of hinges.
- D. Fabricate frames with hardware reinforcement plates projection welded in place. All reinforcing shall be G90 galvanized. Minimum reinforcing gages:
 - 1. Strike reinforcement: 16 gage
 - 2. Hinge reinforcements: 8 gage
 - 3. Lock reinforcements: 16 gage
 - 4. Closer reinforcement: 14 gage
- E. Provide adequate reinforcing for all other hardware as may be specified.
- F. Provide mortar guard boxes.
- G. Prepare interior door frames for silencers. Provide three single silencers for single doors on strike side.
- H. Fabricate frames for heights as shown on the Drawings.

2.05 Finish

- A. Interior and Exterior Units: ASTM A653 G90.
- B. Primer: One coat, baked on, rust inhibiting paint in accordance with ANSI A224.1.
- C. Coat inside of frame profile with bituminous coating to a thickness of 1/16 inch (1.5 mm).

Part 3 Execution

3.01 Examination

- A. Verify substrate conditions under provisions of Section 01 6000, Product Requirements.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that frames have proper interior coating.

3.02 Installation

- A. Deliver frames to the Project Site for installation. Coordinate delivery staging area. Protect until installation.
- B. Install frames in accordance with HMMA 840 and HMMA 830.
- C. Install frames into new masonry walls using masonry strap anchors, minimum of 3 anchors per jamb for a standard pedestrian door (7'0" high). Provide additional anchors for taller doors to maintain a maximum spacing of 2'-0" between anchors.
- D. Install frames in concrete walls or existing masonry walls. Bolt the hollow steel frames to the wall opening edges with the "existing wall anchor assemblies". Provide one assembly each at top and bottom of jamb, not over eight inches away from end and at not over 2 feet between end assemblies, in each jamb. Countersink bolt heads to be flush with the face of the stops, through sleeved spacers behind the stops.
- E. Install frames at structural channel or plate rough openings by welding the frames to the rough opening steel. At each jamb, use four 2-inch long fillet welds at each face of frame (total of 16 welds). At head, use three 2-inch long fillet welds at each face of frame (total of 6 welds).
- F. Install Fire-Rated frames in accordance with NFPA Standard No. 80, and with the requirements of the Owner's Underwriters or the Rating Bureau, as appropriate. Install frames so that when doors are in the closed position, there are no corner or edge gaps between door and frame.
- G. Comply with provisions of SDI-105-92 "Recommended Erection Instructions for Steel Frames", unless otherwise shown.
- H. Mortar frames solid.
- I. Coordinate installation of glass and glazing.
- J. Coordinate installation of frames with installation of hardware specified in Section 08 7100 and doors in Section 08 1313.53.

3.03 Erection Tolerances

A. Maximum Diagonal Distortion: 1/16 inch (1.5 mm) measured with straight edges, crossed corner to corner.

End of Section

Section 08 1313.53 Custom Steel Doors

Part 1 General

1.01 Section Includes

A. Non-rated and rated galvanized metal doors, reinforced for hardware.

1.02 Related Sections

- A. Section 04 2000: Unit Masonry
- B. Section 08 1213.53: Custom Steel Frames
- C. Section 08 7100: Door Hardware
- D. Section 08 8000: Glazing
- E. Section 09 9000: Painting and Coating

1.03 References

- A. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- B. ASTM A591 Steel Sheet, Cold Rolled, Electrolytic Zinc-Coated.
- C. Door Hardware Institute (DHI) The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors and Builder's Hardware.
- D. HMMA 802 Manufacturing of Hollow Metal Doors and Frames.
- E. HMMA 810 Hollow Metal Doors.
- F. HMMA 830 Hardware Preparation and Locations for Hollow Metal Doors and Frames.
- G. HMMA 840 Installation and Storage of Hollow Metal Doors and Frames.
- H. NFPA 80 Fire Doors and Windows.
- I. NFPA 252 Fire Test for Door Assemblies.
- J. UL 10B Fire Tests of Door Assemblies.
- K. ANSI A151.1 Endurance Test.
- L. ANSI 115 Hardware Preparation.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Door Locations and Identification: Submit shop drawings and list the location in building and identification mark for each hollow steel door and frame. Indicate door hardware requirements. Submit manufacturer's printed instructions covering installation of the specified work.
- C. Shop Drawings: Indicate the following:
 - 1. Elevations of each door design.
 - 2. Details of doors including vertical and horizontal edge details.
 - 3. Details and locations of reinforcement and preparations for hardware.
 - 4. Details of anchorages, accessories, joints, and connections.

- 5. Coordination of glazing frames and stops with glass and glazing requirements.
- D. Door Schedule: Use same reference designations indicated on Contract Drawings in preparing schedule for doors and frames.
- E. Oversize Construction Certificates: For door assemblies required to be fire-protection rated and exceeding size limitations of labeled assemblies.

1.05 Performance Requirements

- A. Conform to requirements of HMMA 802, HMMA 810, HMMA 830, HMMA 840, HMMA 850, and ANSI A117.1.
- B. Fire-Rated Door Assemblies: Assemblies complying with ASTM E152 and NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: Test at atmospheric pressure.
 - 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 3. Temperature-Rise Rating: Where indicated, provide doors that have a temperature-rise rating of 450 degrees Fahrenheit (250 degrees Celsius) maximum in 30 minutes of fire exposure.

1.06 Qualifications

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.

1.07 Delivery, Storage, And Handling

- A. Wrap, carton, and crate as required to provide physical and climatic protection during loading, shipping and job site storage and handling.
- B. Deliver packaged materials to the project site in the manufacturer's original, unopened containers which bear intact, legible and visible labels that identify the manufacturer's name and brand name, the contents, grade and type.
- C. Upon delivery, immediately inspect shipments to assure their compliance with the requirements of the Contract Documents and approved submittals, and that products are complete, undamaged and adequately protected. Immediately report damaged, missing, or defective items. Remove broken, damaged or unlabeled items from the site immediately.
- D. Store doors and frames at building site under cover. Place units on minimum 4-inch-high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inch spaces between stacked doors to promote air circulation.
- E. Store products in accordance with manufacturer's instructions with seals and labels intact, legible, and visible. Store products in a manner to prevent damage, soiling, theft, deterioration and contamination. Marred surfaces, cracked, checked split or warped materials will be rejected. Store materials subject to damage by climatic conditions in

weather tight enclosures. Maintain temperature and humidity within the ranges required or recommended by the manufacturer.

F. Repair or clean items that have been damaged or soiled that can be restored to an "as new" condition at no cost to OWNER. OWNER shall be the judge of the effectiveness of remedial measures. Additional time or expenses required to secure replacements and to make repairs will not be considered by OWNER to justify an extension in the Contract time of completion or an increase in the Contract amount.

1.08 Field Measurements

- A. Field measure openings prior to fabrication of doors.
- B. Verify that field measurements are as indicated on the shop drawings.

1.09 Coordination

A. Coordinate the work with door opening construction, door frame and door hardware installation

Part 2 Products

2.01 Door Manufacturers

- A. CECO: Product Medallion Series.
- B. Substitutions: Under provisions of the Specifications.
 - 1. Substitution must meet the gage and galvanizing specification requirements.
 - 2. Doors shall be from the same manufacturer as the hollow metal frames.

2.02 Doors

A. Doors (Rated and Non-rated): Flush seamless doors with glass inserts as indicated on the Contract Drawings.

2.03 Door Construction

- A. Face: Steel, 16 gage, galvanized sheet in accordance with ASTM A653, G90, galvanized both sides; manufactured and fabricated in accordance with HMMA 802 and 810.
- B. 22 gage stiffeners spaced at 6" internally on the door, welded to the face sheets at 5" on center.
- C. Core: Fiberglass insulation to limit thermal and sound transmission.
- D. Door Edge Design: 1/8 inch in 2-inch bevel, hinge and lock edges.
- E. Door Edge Seam: Doors shall have vertical, interlocking, continuous mechanical joints at lock and hinge side with edge seam filled and ground smooth to provide a seamless appearance. The internal portion of the seam shall be sealed with epoxy.
- F. Glass Moldings and Stops:
 - 1. Where indicated on the Drawings doors shall be provided with steel moldings to secure glazing by others in accordance with the glass sizes and thickness indicated and specified.
 - 2. Fixed glass moldings shall be welded to the exterior side (secure side) of the door.

- 3. Removable glass stops shall be channels that are a minimum 20 gage with tight fitting corners and secured with shall be secured with countersunk philips head machine screws; provide a minimum of two screws per each length of molding; where length is more than 18 inches long, provide additional screw anchorage at not over 12 inches on center. Moldings shall be mounted flush into the door or frame without overlapping the door or frame face sheet.
- 4. Metal surfaces shall be galvanized similar to the door and finished to match the door primer as shipped from the factory.

2.04 Fabrication

- A. Fabricate doors with galvanized hardware reinforcement welded in place. Prepare doors to receive mortised hardware unless noted otherwise in Section 08 7100, Door Hardware.
- B. Fabricate fire doors to UL requirements for labeling as designated in the Door Schedule on the Contract Drawings. Attach fire rated label to each door unit.
- C. Close top and bottom edge of all doors with steel channel closure. Weld seams watertight. Top of door shall be flush, bottom channel closure shall be inverted.
- D. Mortise exterior doors for 2 pair hinges.
- E. Fabricate doors with hardware reinforcement plates projection welded in place. Reinforcing shall be G90 galvanized. Minimum reinforcing gages:
 - 1. Hinge reinforcements: 7 gage minimum.
 - 2. Lock reinforcements: 16 gage minimum.
 - 3. Closer reinforcement: 12 gage box minimum.
- F. Provide adequate reinforcing for all other hardware as may be specified.

2.05 Finish

- A. Doors and Transom Panel: ASTM A653 G90 galvanizing.
- B. Primer: Shop applied, baked on, rust inhibited paint, compatible with galvanized surfaces.
- C. Shop primer shall be compatible with finish coats applied in the field.
- D. Doors and transom panel shall be field painted as specified in Section 09 9000; color shall be as selected by OWNER.

Part 3 Execution

3.01 Examination

- A. Verify substrate conditions are ready to receive work.
- B. Verify that opening sizes and tolerances are acceptable.

3.02 Installation

- A. Install doors in accordance with HMMA 840 and HMMA 830 DHI for hardware installation.
- B. Assemble door hardware, place accurately and attach securely to the doors and frames.
- C. Hang doors to fit closely in frames without binding; to be in full contact with stops at all points when closed; to swing easily and quietly, without striking the floor at any point of the swing; and to remain in any position left between opened and closed without moving. Exterior doors shall be weathertight when closed.
- D. Fit doors accurately in frames, within clearances specified in ANSI A250.8.
- E. Thermal insulated door perimeter seals shall be adjusted for proper operation.
- F. Coordinate installation of glass and glazing.
- G. Coordinate installation of doors with installation of frames specified in Section 08 1213.53 and hardware specified in Section 08 7100.

3.03 Erection Tolerances

A. Maximum Diagonal Distortion: 1/16-inch measured with straight edge, corner to corner.

3.04 Field Quality Control

A. After doors are installed, test-demonstrate in the presence of OWNER that the doors operate properly under all conditions. Adjust doors and door hardware if tests show improper functioning.

3.05 Adjusting and Cleaning

- A. Adjust door for smooth and balanced door movement.
- B. Prime Coat Touch-up: Immediately after installation, sand smooth any rested or damaged areas of prime coat and apply touch up of compatible air-drying primer.
- C. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

Part 1 General

1.01 Section Includes

A. New single glazed storm windows located at the inboard side of the existing windows at the Pump Station building.

1.02 Related Sections

- A. Section 07 9200: Joint Sealants
- B. Section 08 8800: Glazing

1.03 References

- A. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum.
- B. AAMA 1002 Secondary Storm Products for Windows and Sliding Glass Doors
- C. AAMA 2605 Superior Performing Organic Coatings on Architectural Aluminum Extrusions and Panels.
- D. E283/E283M Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors
- E. E330/E330M Structural Performance of Exterior Windows, Curtain Walls, and Doors Under the Influence of Wind Loads
- F. E331-00 Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

1.04 Performance Requirements

- A. General: Provide aluminum windows engineered, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading without failure, as demonstrated by testing manufacturer's standard window assemblies representing types, grades, classes, and sizes required for Project according to test methods indicated.
- B. Test Criteria: Testing shall be performed by a qualified independent testing agency based on the following criteria:
 - 1. Heights of window units above grade at window centerline are indicated on or can be determined from the Drawings. Consult with ENGINEER, if necessary, to confirm required loading and test pressures.
 - 2. Test Procedures: Test window units according to ASTM E 283 for air infiltration, both ASTM E 331 and ASTM E 547 for water penetration, and ASTM E 330 for structural performance.
- C. Performance Requirements: Testing shall demonstrate compliance with requirements indicated in AAMA 101 for air infiltration, water penetration, and structural performance for type, grade, and performance class of window units required. Where required design pressure exceeds the minimum for the specified window grade, comply with requirements of AAMA 101, Section 3, "Optional Performance Classes," for higher than minimum performance class.

- 1. Air-Infiltration Rate for Fixed Windows: Not more than 0.06 cfm/ft. of area for an inward test pressure of 6.24 lbf/sq. ft. (299 Pa).
- 2. Water Penetration: No water penetration as defined in the test method at an inward test pressure of 15 percent of the design pressure.
- 3. Structural Performance: No failure or permanent deflection in excess of 0.4 percent of any member's span after removing the imposed load, for a positive (inward) and negative (outward) test pressure of 30 lbf/sq. ft. (1437 Pa).
- 4. Condensation Resistance: Where window units are indicated to be "thermally improved," provide units tested for thermal performance according to AAMA 1503.1 showing a condensation resistance factor (CRF) of 45.
- 5. Thermal Movements: Provide window units that allow thermal movement resulting from the following maximum change (range) in ambient temperature when engineering, fabricating, and installing aluminum windows to prevent buckling, opening of joints, and overstressing of components, connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to solar heat gain and nighttime sky heat loss.
 - a. Temperature Change (Range): 120 degrees Fahrenheit (67 degrees Celsius), ambient; 180 degrees Fahrenheit (100 degrees Celsius), material surfaces.

1.05 Submittals for Review

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data for each type of window required, including the following:
 - 1. Construction details and fabrication methods.
 - 2. Profiles and dimensions of individual components.
 - 3. Data on hardware, accessories, and finishes.
 - 4. Recommendations for maintaining and cleaning exterior surfaces.
- C. Shop Drawings showing fabrication and installation of each type of window required including information not fully detailed in manufacturer's standard Product Data and the following:
 - 1. Layout and installation details, including anchors.
 - 2. Elevations at 1/4 inch = 1 foot (1:50) scale and typical window unit elevations at 3/4 inch = 1 foot (1:20) scale.
 - 3. Full-size section details of typical composite members, including reinforcement and stiffeners.
 - 4. Location of weep holes.
 - 5. Panning details.
 - 6. Hardware, including operators.
 - 7. Window cleaning provisions.
 - 8. Glazing details.
 - 9. Accessories.

- D. Samples for initial color selection on 12-inch- (300-mm-) long sections of window members. Where finishes involve normal color variations, include Sample sets showing the full range of variations expected.
- E. Samples for Verification: ENGINEER reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.
- F. Test reports from a qualified independent testing agency indicating that each type, grade, and size of window unit complies with performance requirements indicated based on comprehensive testing of current window units within the last 5 years. Test results based on use of down-sized test units will not be accepted.

1.06 Quality Assurance

- A. Installer Qualifications:
 - 1. Company specializing in performing the work of this section with minimum ten years' experience, approved by the manufacturer.
 - 2. Must have documented experience in the installation of storm windows in designated historical buildings similar to the current project scope in the last ten years.
- B. Product Options: The Drawings indicate sizes, profiles, dimensional requirements, and aesthetic effects of aluminum windows and are based on the specific window types and models indicated. Other aluminum window manufacturers whose products have equal performance characteristics may be considered, provided deviations in size, profile, and dimensions are minor and do not alter the aesthetic effect. Refer to Division 1 Section "Substitutions."

1.07 **Project Conditions**

A. Field Measurements: Check window openings by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.08 Warranty

- A. General Warranty: The special warranty 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 Warranty: Submit a written warranty signed by aluminum window manufacturer agreeing to repair or replace window components that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period for Metal Finishes: 10 years after date of Substantial Completion.

Part 2 Products

2.01 Manufacturers

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kawneer 8225TL Thermal Windows, 2-1/4 inches frame depth.
 - 2. DeSCo Architectural Inc. i65 Series, 2-3/4 inches frame depth.
- B. Substitutions, Materials and Equipment: Product substitutions permitted in accordance with Section 01 2513, Substitution Procedures.

2.02 Materials

- A. Aluminum Extrusions: Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish.
- B. Fasteners: Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components of window units.
- C. Exposed Fasteners: Except where unavoidable for application of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
- D. Anchors, Clips, and Window Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel or iron complying with requirements of ASTM B 633; provide sufficient strength to withstand design pressure indicated.
- E. Compression-Type Glazing Strips and Weatherstripping: Unless otherwise indicated, and at manufacturer's option, provide compressible stripping for glazing and weatherstripping such as molded EPDM or neoprene gaskets complying with ASTM D 2000 Designation 2BC415 to 3BC620, or molded PVC gaskets complying with ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
- F. Sealant: For sealants required within fabricated window units, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating. Comply with Section 07 9200, Joint Sealants for selection and installation of sealants.

2.03 Accessories

A. General: Provide manufacturer's standard accessories that comply with indicated standards.

2.04 Fabrication

- A. General: Fabricate aluminum window units to comply with indicated standards. Include a complete system for assembly of components and anchorage of window units.
 - 1. Provide units that are reglazable without dismantling sash or ventilator framing. Glazing must be able to be easily replaced from the interior side.
 - 2. Prepare window sash or ventilators for glazing, except where preglazing at the factory is indicated.

3. Glazing Stops: Provide screw-applied or snap-on glazing stops, coordinated with glass selection and glazing system indicated. Finish to match window units.

2.05 Finishes

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- C. Powder Coated Finish: AAMA 2605. 70% PVDF Exterior Powder Coated Finish.
 - 1. Color: As selected by ENGINEER from the full range of manufacturer colors.

Part 3 Execution

3.01 Inspection

- A. Inspect openings before installation. Verify that rough or masonry opening is correct and sill plate is level.
 - 1. Masonry surfaces shall be visibly dry and free of excess mortar, sand, and other construction debris.
 - 2. Metal surfaces shall be dry; clean; free of grease, oil, dirt, rust and corrosion, and welding slag; without sharp edges or offsets at joints.

3.02 Installation

- A. Comply with manufacturer's specifications and recommendations for installing window units and other components of the Work.
- B. Set window units plumb, level, and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.
 - 1. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified under "Dissimilar Materials" Paragraph in appendix to AAMA 101.
- C. Set sill members and other members in a bed of sealant or with joint fillers or gaskets, as shown on Shop Drawings, to provide weathertight construction. Refer to Section 0 9200, Joint Sealants for compounds, fillers, and gaskets to be installed concurrently with window units. Coordinate installation with wall flashings and other components of the Work.
 - 1. Sealants, joint fillers, and gaskets to be installed after installation of window units are specified in another Division 7 Section.

3.03 Adjusting

A. Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and a weathertight closure.

3.04 Cleaning

A. Clean aluminum surfaces promptly after installing windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

3.05 Protection

A. Provide final protection and maintain conditions, in a manner acceptable to aluminum window manufacturer, that ensure window units are without damage or deterioration at the time of Substantial Completion.

Part 1 General

1.01 Section Includes

- A. Hardware for hollow steel doors.
- B. Thresholds.
- C. Weatherstripping, seals and door gaskets.

1.02 Related Sections

- A. Section 08 1313.53: Custom Steel Doors
- B. Section 08 1213.53: Custom Steel Frames

1.03 References

- A. ANSI A117.1 Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
- B. NFPA 80 Fire Doors and Windows.
- C. NFPA 101 Code for Safety to Life from Fire in Buildings and Structures.
- D. NFPA 252 Fire Tests of Door Assemblies.
- E. UL 10B Fire Tests of Door Assemblies.
- F. UL 305 Panic Hardware.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate locations and mounting heights of each type of hardware, and material types.
- C. Submit manufacturer's parts lists, and templates to steel door and frame manufacturers for mortising of steel doors and frames. All necessary templates and schedules shall be provided at such time so not to delay the Work. Refer to Delivery, Storage and Handling herein for forwarding requirements of hardware.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.05 Project Record Documents

- A. Submit under provisions of Section 01 6000, Product Requirements.
- B. Record actual locations of installed cylinders and their master key code.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.07 Quality Assurance

- A. Perform work in accordance with the following requirements:
 - 1. ANSI A117.1 Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
 - 2. NFPA 101.
 - 3. NFPA 80.
 - 4. NFPA 252.

1.08 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Hardware Supplier: Company specializing in supplying industrial quality door hardware, approved by manufacturer to install their products.
- C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this Section.

1.09 Regulatory Requirements

A. Conform to applicable code for requirements for fire rated doors and frames.

1.10 Delivery, Storage, And Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Upon request, the Contractor shall submit physical hardware as required, direct to door manufacturer's plant for installation. Such shipments shall be forwarded, prepaid.
- C. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.
- D. Provide construction cores and cylinders; upon completion of the Work, install new cores and cylinders as necessary for OWNER approval.
- E. Deliver keys for final cylinders to OWNER by security shipment direct from hardware supplier.

1.11 Coordination

A. Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.

1.12 Warranty

- A. Provide five-year warranty under provisions of Section 01 6000, Product Requirements.
- B. Warranty: Include coverage for door closers.

1.13 Maintenance Materials

A. Provide maintenance materials under provisions of Section 01 6000, Product Requirements.

- B. Provide special wrenches and tools applicable to each different or special hardware component.
- C. Provide maintenance tools and accessories supplied by hardware component manufacturer.

Part 2 Products

2.01 Hardware for Metal Doors

- A. Description of Hardware Components:
 - 1. The following description of designated hardware components is limited to elements that are established as constants throughout the project and are not intended to be complete.
 - 2. When a description is coupled with criteria established under the heading "Hardware Sets," the hardware for a particular opening will be complete to the extent necessary for a satisfactory installation and operation of the door.
 - 3. The descriptions contain "Key Words" which when used in the hardware sets in conjunction with other notations, will establish the hardware elements assigned to the individual door.
- B. Hinges:
 - 1. Stainless steel with ball bearings (steel hinges on fire rated doors), flat button tip, Stanley FBB 199 32D, Hager BB 1199, Ives A5111 or McKinney No. T4B3386.
 - 2. Hinges shall be 4-1/2" x 4-1/2" minimum 0.180 inches thick stainless steel with stainless steel pins.
 - 3. Exterior doors shall have 2 pair, (U.N.O.).
 - 4. Exterior doors shall have non-removable pins (NRP).
- C. Mortise Locks:
 - 1. Corbin/Russwin ML2000 series, Schlage L9000 series or Best 40H series hardware, for severe climatic conditions or marine use with all stainless steel and bronze construction to resist corrosion, including non-ferrous or stainless steel case. Match cylinder type and keying to OWNER's current standard.
 - 2. Inside lever always free for egress.
 - 3. Minimum ³/₄-inch latch bolt throw designed to accept 1-5/32 inch diameter standard cam cylinder and adjustable from flat front to standard bevel either hand.
 - 4. Provide exterior doors with lock protector plates.
 - 5. Levers shall be cast stainless steel; escutcheons shall be wrought stainless steel.
 - 6. Each lockset set shall be furnished complete with one pair of levers and escutcheons.
 - 7. Lever and Escutcheon model shall be Corbin/Russwin "ASM", Schlage "L07" or Best "16M".

- D. Exit Devices:
 - 1. US-26D smooth case with stainless steel touch bar and lever trim, mortised cylinder recess:
 - 2. Base unit for rated and non-rated doors:
 - a. Von Duprin, No. 9875L x 996L break away lever design
 - b. Precision Apex Series 2300 x V4908A
 - 3. Provide matching Von Duprin 9827 Series or Apex 2200 Series, UL labeled device for fire rated double doors (provide vertical rod and bottom latch guards for this unit).
 - 4. Interior doors do not require cylinders, unless noted in the hardware sets below.
 - 5. Provide blank escutcheons for these locations; trim shall always be operable.
 - 6. Strikes shall be stainless steel, dustproof; coordinate with exit devices, as required.
 - 7. Provide tamperproof security type screws for installation.
 - 8. Hardware for mechanical and electrical rooms shall have knurled levers.
- E. Closers:
 - 1. Surface mounted closer with cast iron cylinder, adjustable back check, and spring power with key valve adjusting screws for closing and latching speeds and back check control.
 - 2. Closer arms shall allow for minimum 100-degree swing.
 - 3. Closers shall be LCN 4000 Series, Ryobi D4550 or Engineer approved equal, resistant to severe climatic conditions with a U.S.-26D sprayed finish on covers.
 - 4. Provide SRI finish on closer bodies and arms.
 - 5. Required accessories, brackets, plates, arms, spacers, etc, required for a complete installation shall be provided whether specifically called for or not.
 - 6. Closers on exterior doors shall be mounted on the interior side of the door.
- F. Kickplates:
 - 1. Dull stainless steel (US32D), (0.050) gauge 10-inch high except at doors with narrow bottom stiles where the height shall be reduced to 1/2-inch less than the height of the rail and shall be 1-1/2 inches LDW on push side of single doors, 1-inch LDW on push side of pairs of doors.
 - 2. Mount kickplates flush with lock style edge of pairs of doors.
 - 3. Provide kickplates push side of all hollow metal doors.
- G. Thresholds:
 - 1. Thermally broken, Barrier Free Accessible, 5-inch-wide, full width of door frame, Zero Model No. 625A, National Guard Products Model No. 8425, or Reese Model No. S282D; finish shall be aluminum mill finish.

- 2. Provide one threshold for each exterior door opening.
- H. Weatherstripping:
 - 1. Durable Products, National Guard Products, Reese, Zero or Pemco.
 - 2. Model No. listed are National Guard Products (NGP).
 - 3. Head and jambs, NGP No. 160VA.
 - 4. Door bottom brush seal, NGP D608A.
 - 5. Finish for weatherstripping shall be natural satin clear anodized aluminum.
 - 6. Provide weatherstrip for all exterior doors.
 - 7. Backpaint surfaces in contact with dissimilar metals for protection prior to installation.
- I. Lock Protectors
 - 1. Single exterior pedestrian doors shall be provided with lock protectors similar to Glynn Johnson LP series in stainless steel.
 - 2. Coordinate exact model with door exit devices to insure proper clearances.
 - 3. Substitutions: Under provisions of Section 01 2513, Substitution Procedures.

2.02 Keying

- A. Locks shall be capable of accepting minimum six (6) pin cores and cylinders matching OWNER's present system, master keyed to OWNER's approved system.
- B. Supply keys in the following quantities:
 - 1. 4 keys per cylinders, plus:
 - a. 4 master keys.
 - b. 4 grand master keys.

2.03 Finishes

- A. Finishes: Satin chrome, U.S. 32D or 26D, when U.S. 32D is not available, unless otherwise noted in hardware product descriptions or schedule.
- B. Hardware screws, fasteners, etc. shall be Type 304 stainless steel.

Part 3 Execution

3.01 Examination

- A. Verify site conditions under provisions of Section 01 1100, Summary of Work.
- B. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings and instructed by the manufacturer.

3.02 Installation

A. Install hardware in accordance with manufacturer's instructions.

- B. Use templates provided by hardware item manufacturer.
- C. Mounting heights for hardware from finished floor to center line of hardware item shall be per current State of Michigan, Barrier Free Code requirements.
- D. Thresholds shall be set in 2 continuous beads of sealant.

3.03 Field Quality Control

- A. Field inspection will be performed under provisions of Section 01 4500, Quality Control.
- B. Architectural Hardware:
 - 1. Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.
 - 2. CONTRACTOR shall submit a letter from the Architectural Hardware Consultant certify the installation.

3.04 Adjusting

- A. Adjust work under provisions of Section 01 7700, Closeout Procedures.
- B. Adjust hardware for smooth operation.

3.05 **Protection of Finished Work**

- A. Protect finished Work.
- B. Do not permit adjacent work to damage hardware or finish.

3.06 Schedule

A. Set 01:

| Hinge – 2 Pair | Mortise Lockset – Classroom Function | Closer | Kickplate |
|----------------|---|------------------|-----------|
| Lock Protector | Threshold | Weatherstripping | |

Section 08 8000 Glazing

Part 1 General

1.01 Section Includes

A. Glass and glazing for windows and doors.

1.02 Related Sections

- A. Section 07 9200: Joint Sealants
- B. Section 08 1313.53: Custom Steel Doors

1.03 References

- A. ANSI Z97.1 Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
- B. ASTM C669 Glazing Compounds for Back Bedding and Face Glazing of Metal Sash.
- C. ASTM C804 Use of Solvent Release Type Sealants.

1.04 Submittals

- A. Submit manufacturer's literature of proposed products for review by ENGINEER in accordance with Section 01 3300, Submittal Procedures.
- B. Certificates: Certify that Products meet or exceed specified requirements.

1.05 Quality Assurance

- A. Installer Qualifications:
 - 1. Company specializing in performing the work of this section with minimum ten years' experience, approved by the Manufacturer.
 - 2. Must have documented experience in the installation of storm windows in designated Historical buildings similar to the current project scope in the last ten years.

1.06 Environmental Requirements

- A. Section 01 6000, Product Requirements: Environmental conditions affecting products on site.
- B. Do not install glazing when ambient temperature is less than 50 degrees Fahrenheit (10 degrees Celsius).
- C. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 Environmental Requirements

A. Section 01 7700, Closeout Procures.

2.01 Glass

- A. Replacement Glazing at Existing Window Frames: Clear tempered glass, thickness and edge profile to match existing. Provide Low-E coating on inboard side, similar to Guardian SN 68.
- B. New Glazing at New Windows: Clear tempered glass, 1/4-inch thick.
- C. Glass tint color shall be selected from manufacturer's full range of available colors. Provide samples for review and approval.

2.02 Glass Manufacturers

- A. Guardian Industries
- B. PPG
- C. Tempglass Inc.
- D. Substitutions: Refer to Section 01 2513, Substitution Procedures.

2.03 Glazing

A. Sash manufacturer's standard system.

Part 3 Execution

3.01 Examination

- A. Verify existing conditions before starting work.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 Preparation

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant.
- D. Install sealant in accordance with manufacturer's instructions.

3.03 Installation

- A. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.
- B. Rest glazing on setting blocks.
- C. Install spacer shims or pre-shimmed tape inserted between glazing and door frame as required to secure glass, 1/4 inch (6 mm) below sight line.
- D. Fill gaps between pane and shims with continuous, gunnable sealant to depth equal to bite on glazing with bevel or watershed away from glass.

3.04 Field Quality Control

- A. Section 01 4500, Quality Control: Field inspection.
- B. Inspection will monitor quality of glazing.

3.05 Cleaning

- A. Section 01 7700, Closeout Procedures: Cleaning installed work.
- B. Remove glazing materials from finish surfaces.
- C. Remove labels after Work is complete.
- D. Clean glass and adjacent surfaces

3.06 Protection of Finished Work

- A. Section 01 7700, Closeout Procedures: Protecting installed work.
- B. After installation, mark pane with an 'X' by using removable plastic tape or paste.

Division 09 Finishes

Section 09 1000 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 09 9000 Painting and Coatings
- B. Division 23: Heating, Ventilating, and Air-Conditioning
- C. Division 26: Electrical
- D. Division 40: Process Integration
- E. Division 41: Material Processing and Handling Equipment
- F. Division 42: Process Heating, Cooling, and Drying Equipment
- G. Division 43: Process Gas/Liquid Handling, Purification, & Storage Equipment

1.03 Submittals

A. In accordance with Section 01 3300, 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 1) color coding in accordance with the Piping Identification Schedule; 2) a painted label; and 3) and a directional flow arrow. 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.
- C. Color Bands and Arrows:
 - 1. Pipe color bands shall be painted on the pipe. Paper or plastic banding of pipe shall not be acceptable.
 - 2. Arrows shall be of the same color as the lettering and shall point away from the lettered labels in the direction of the flow.

3. Color band size shall be as follows:

| Pipe Size (Outside Diameter) | Color Band Width |
|------------------------------|------------------|
| < 1" | 1" |
| 1" – 12" | 1 pipe diameter |
| > 12" | 12" |

- D. Lettering:
 - 1. Contents identification labels shall be stenciled directly on pipes.
 - 2. Black identification letters shall be used where the background pipe color is light, and white identification letters where the background color is dark.
 - 3. 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 Article 3.04 of 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 the Engineer.
- B. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all 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 | | |
|-------------------------------------|--------------------------|--|--|
| Domestic Water | | | |
| Potable Water (RP Device) | Light Blue | | |
| Fresh Water (Air Gap) | Light Blue | | |
| Industrial and/or Cooling Water | | | |
| 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 | | |
| Cooling Water Supply-Plant Effluent | Dark Blue/Red | | |
| Cooling Water Return-Plant Effluent | Dark Blue/Red | | |

| Type of Service | Pipe Color / Strip Color | |
|---|---------------------------------|--|
| 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 | |
| Chemical Supply Lines (Extremely Dangerous) | | |
| 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 (H2S 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 | |

| Type of Service | Pipe Color / Strip Color | |
|--|--------------------------|--|
| 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 | |
| Pneumatic Transport Lines | | |
| Sludge Derived Fuel | Light Green/Orange | |
| Hot Ash | Light Green/Yellow | |
| Sand Transport | Light Green | |
| Air and Vacuum Supply Lines | | |
| Oxygen (gaseous) | Purple/Black | |
| Oxygen (liquid) | Purple/Black | |
| Combustion Air | Green | |
| Compressed Air (non-instrument) | Green/Red | |
| Air and Vacuum Supply Lines | | |
| 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 | |
| Boiler Waters | | |
| 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 | |
| Reverse Osmosis Treated Water (permeate) | Dark Blue/Orange | |

| Type of Service | Pipe Color / Strip Color | |
|--|---|--|
| Steam | | |
| Low-pressure Steam | Orange/Red | |
| Medium-pressure Steam | Orange/Red | |
| High-pressure Steam | Orange/Red | |
| Lube and Hydraulic Oils | | |
| 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 | |
| Fuel Supply | | |
| 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 | |

Section 09 6700 Epoxy-Based Flooring

Part 1 General

1.01 Section Includes

- A. Epoxy base flooring section includes coating of concrete floors for the various rooms and areas indicated on the Drawings.
- B. Pump Station Building shall have the lower level floor coated per plans.
- C. Where floor abuts building wall, provide a 4-inch high coating of the epoxy system to act as a painted base for walls and equipment pads.

1.02 References

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. American Society For Testing And Material (ASTM)
 - a. ASTM C 722 Chemical-Resistant Resin Monolithic Surfacing

1.03 Submittals

- A. Industrial epoxy-based flooring manufacturer's descriptive data, mixing, proportioning, and installation instructions. Maintenance literature for epoxy flooring shall be included.
- B. Drawings indicating the type and layout of the floor system.
- C. Certificates indicating conformance with specified requirements and flooring manufacturers approval of the flooring applicator. Certificate shall be accompanied by certified test reports from an approved laboratory showing that the epoxy floor coating has been tested and meets the requirements specified.
- D. Two 150 by 150 mm, 6 by 6 inches, (minimum) samples of each color of industrial resinous flooring.

1.04 Qualifications of Applicator

A. Applicator shall be approved by the flooring manufacturer and shall have a minimum of 5 years' experience in the application of the materials to be used.

1.05 Delivery and Storage

A. Materials shall be delivered to the project site in manufacturer's original unopened containers. Materials shall be kept in a clean, dry, area with temperatures controlled between 10 to 33 degrees C, 50 to 90 degrees F.

1.06 Environmental Requirements

- A. Section 01 6000, Product Requirements: Environmental conditions affecting products on site.
- B. Areas to receive industrial resin-based flooring shall have the slab and atmosphere maintained at a temperature above 60 degrees F for 2 days prior to installation and for 7 days following installation.

Part 2 Products

2.01 Manufacturers

- A. The following manufacturers shall be used to the extent their epoxy-based flooring meets the requirements of this specification:
 - 1. Thin Film Epoxy, Urethane Topcoat, Semi-Gloss
 - a. Surface Preparation: SSPC SP-13, ICRI CSP 2-3 Surface Profile
 - b. Primer: Tnemec Series 237 Power-Tread applied at 6.0 to 8.0 mils DFT
 - c. Intermediate Coat: Tnemec Series 237 Power-Tread applied at 6.0 to 8.0 mils DFT.
 - d. Topcoat: Tnemec Series 290 CRU applied at 2.0 to 3.0 mils DFT
 - 2. Thin Film Epoxy, Urethane Topcoat, Gloss
 - a. Surface Preparation: SSPC SP-13, ICRI CSP 2-3 Surface Profile
 - b. Primer: Sherwin Williams GP 3746 High Performance Epoxy applied at 6.0 to 8.0 mils DFT
 - c. Intermediate: Sherwin Williams GP 3746 High Performance Epoxy applied at 6.0 to 8.0 mils DFT
 - d. Topcoat: Sherwin Williams GP 4638 HS Polyurethane applied at 2.0 to 3.0 mils DFT
 - 3. Thin Film Epoxy, Urethane Topcoat, Gloss
 - a. Surface Preparation: SSPC SP-13, ICRI CSP 2-3 Surface Profile
 - b. Primer: Carboline Carboseal 720 applied at 6.0 to 8.0 mils DFT
 - c. Intermediate: Carboline Carboseal 705 applied at 10.0 to 12.0 mils DFT
 - d. Topcoat: Carboline Carboseal 835 Urethane applied at 2.0 to 3.0 mils DFT
 - 4. Epoxy-Based Flooring specified under this Section and Paint products specified under Section 09 9000, Painting and Coating, shall be procured from the same coatings manufacturer.

2.02 Industrial Epoxy-Based Flooring

- A. Industrial epoxy-based flooring.
 - 1. Material shall be 100% solids (mixed).
 - 2. Minimum application temp 65 degrees Fahrenheit.
- B. Minimum final thickness of Resin Based Flooring shall be 14.0-19.0 dry mils.

2.03 Fillers

- A. Fillers shall be inert silica, quartz or other hard aggregate material as recommended by the flooring manufacturer.
 - 1. Fillers shall be furnished in the quantity necessary to impart the required color and physical characteristics.

- 2. The filler shall contain sufficient fines (30/50) to provide an even-textured, nonslip type of surface on the finished topping.
- 3. Filler shall be broadcast into topcoat and topcoat shall be back rolled to provide a uniform slip resistant floor.

2.04 Wall Base

- A. Self-coving shall be used at walls, curbs, and equipment pads.
 - 1. Self-coving shall consist of industrial epoxy-based flooring coved up at the base of the wall 4 inches.
 - 2. Coved base material application shall be the same thickness as the flooring.

2.05 Color

- A. Color shall be OWNER selected from the complete range available from the manufacturer.
- B. Samples shall be submitted to OWNER for selection as part of the submittals.

Part 3 Execution

3.01 Preparation of Concrete Subfloor

- A. Installation of the floor topping shall not commence until the concrete substrate (repair areas) is at least 28 days old.
- B. CONTRACTOR shall temporarily relocate, at the direction of OWNER, items that will interfere with applying the epoxy-based flooring.
- C. Existing concrete floors shall be cleaned and prepared in accordance with the manufacturer's printed instructions for existing concrete.
- D. Existing staining on the floors shall be removed or neutralized so the new coating will bond to the floor.
- E. New concrete floor surfaces shall be prepared in accordance with the manufacturer's printed instructions for new concrete.

3.02 Mixing, Proportioning, and Installation

- A. Mixing, proportioning, and installing shall be in accordance with the approved instructions of the manufacturer.
- B. Aggregate shall be broadcast into the resin flooring at a uniform rate consistent with the manufacturer's recommendations to provide a uniform surface appearance.

3.03 Protection of Finished Work

- A. Section 01 7700, Closeout Procedures: Protecting installed work.
- B. Epoxy flooring shall be covered and protected from damage until completion of the work of other trades.

Section 09 9000 Painting and Coating

Part 1 General

1.01 Section Includes

- 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 Sections

- A. Section 04 0513: Mortar and Masonry Grout
- B. Section 05 1200: Structural Steel Framing
- C. Section 05 5000: Metal Fabrications
- D. Section 08 1213.53: Custom Steel Frames
- E. Section 08 1313.53: Custom Steel Doors

1.03 References

- 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 3300.
- B. Product Data: Provide data on all products and special coatings. Data shall include manufacturer's suggested surface preparation and coating thicknesses.
- C. Samples: Submit two samples, 1-inch x 3-inch (25 x 76 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Manufacturer's Instructions: Indicate special surface preparation procedures, substrate conditions requiring special attention, environmental considerations and any restrictions regarding time recoat.

- E. A letter certifying the installer as a Manufacturer's Approved Installer shall accompany the submittal package.
- F. Daily Coating Inspection Reports (blank version included at the end of this Section) are to be submitted weekly to ENGINEER. One report is to be completed for each day of painting activity performed on the job site. Reports must be fully filled out. Payment may be withheld if reports are not submitted in a timely fashion or are not fully completed.

1.06 Qualifications

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section and one of the four companies listed.
- B. Applicator:
 - 1. Company specializing in performing the work of this section with minimum ten years' experience, approved by manufacturer.
 - 2. Must have documented experience in the preparation and application of paint on a minimum of two designated historical buildings similar to the current project scope in the last ten years.

1.07 Delivery, Storage and Handling

- A. Deliver, store, protect and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- C. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Only materials approved for use on this project shall be delivered to the site.
- E. Store paint materials at minimum ambient temperature of 45 degrees Fahrenheit (7 degrees Celsius) and a maximum of 90 degrees Fahrenheit (32 degrees Celsius), in ventilated area, and as required by manufacturer's instructions.
 - 1. Material found on the project that is stored in areas that are outside of the above temperature requirements shall not be used on the project and shall immediately be removed from the site.

1.08 Environmental Requirements

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating product manufacturer.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- C. Minimum Application Temperatures for Latex Paints:
 - 1. Minimum application temperatures shall be as required by the coating manufacturer's instructions.
 - 2. If there are no explicit printed recommendations by the manufacturer, minimum temperature of the air and surface to be painted shall be 50 degrees Fahrenheit.

- D. Provide lighting level of 80-foot candles (860 lx) measured mid-height at substrate surface during coating operations in the area being painted.
- E. Provide adequate ventilation for enclosed spaces. Additional ventilation may be required to prevent fumes from affecting adjacent OWNER-occupied spaces.

1.09 Surfaces Not Requiring Painting

- A. Aluminum (except for backcoating as specified in Section 3.2F).
- B. Stainless Steel.
- C. Copper.
- D. FRP.
- E. PVC, CPVC, HDPE and Fiberglass Pipe and Ductwork (including hangers).
- F. PVC Coated Electrical Conduit.
- G. Inside of pipe spaces, duct shafts, and similar areas not exposed to view.
- H. Exterior galvanized grating or checkered plate need not be painted, except to meet MIOSHA requirements.

1.10 Existing Painted Surfaces

A. CONTRACTOR is to assume that existing painted surfaces that will be affected by project activities contain lead. Paint at affected surfaces is to be removed and abated in accordance with all federal, state and local regulations and guidelines as part of this work scope. Provide documentation of compliance methods to OWNER for record as part of submittals.

Part 2 Products

2.01 Manufacturers

- A. Manufacturers Paint and Special Coatings
 - 1. Tnemec Company
 - 2. Carboline Company
 - 3. Sherwin-Williams Company
- B. Substitutions: No substitutions are allowed.
- C. Products used on this project shall be from the same manufacturer unless written authorization is received from ENGINEER.

2.02 Materials

- A. Coatings:
 - 1. Ready mixed, except field catalyzed coatings.
 - 2. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.
- B. Accessory Materials:

- 1. As recommended by the manufacturer and required to achieve the finishes specified, of commercial quality.
- C. Patching Materials:
 - 1. Latex filler.

2.03 Finishes

- A. Refer to schedule at end of section for surface finish schedule.
- B. Colors will be selected by OWNER from color samples submitted.

Part 3 Execution

3.01 Examination

- A. Verify site conditions under provisions of the General Conditions.
- B. Verify that surfaces and/or substrate conditions are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Commencement of the coating operations will signify acceptance of the substrate(s) as being suitable for the coating and ability to achieve the final results specified.
- E. Test shop applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 2. Concrete Floors: 8 percent. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.

3.02 Preparation

- A. Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- B. Correct defects and clean surfaces which affect work of this section.
 - 1. Remove existing coatings that exhibit loose surface defects.
- C. Marks:
 - 1. Seal with a stain-blocking primer marks which may bleed through surface finishes.
- D. Mildewed Surfaces:
 - 1. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach.
 - 2. Rinse with clean water and allow surface to dry.
- E. Aluminum Surfaces shall be backcoated with OWNER approved epoxy/sealer (Tnemec Series N69 or Carboline Rustbond penetrating sealer; or Sherwin-Williams Macropoxy 646 or Amerlock sealer) prior to installation to provide separation of dissimilar materials.

- 1. CONTRACTOR shall note that all dissimilar materials shall be kept from direct contact by the use of approved insulating and isolating materials.
- 2. Surfaces shall be clean and if necessary, treated with Clean'n Etch, Great Lakes Laboratories Livonia, Michigan.
- F. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish:
 - 1. Remove foreign particles to permit adhesion of finishing materials.
 - 2. Apply compatible sealer or primer.
- G. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- H. Fiberglass, PVC, CPVC or HDPE piping and connected items as shown on the drawings shall remain unpainted.
 - 1. However, stenciled painted arrows, color bands, etc. shall be provided to agree with OWNER's Standard Color Code.
 - 2. Surface shall be lightly sanded below code markings prior to painting to obtain a roughened surface.
 - 3. Surface shall then be wiped with approved thinner solution.
 - 4. Markings shall then be applied as soon as the thinner has dried.
- I. Galvanized Surfaces Priming:
 - 1. Galvanized surfaces scheduled for painting shall not be water quenched at the end of the galvanizing process.
 - 2. Remove gloss from the new spangled galvanizing by sweep blasting in accordance with the SSPC SP-16 Brush Off Blast Cleaning of Coated or Uncoated Galvanized Steel, Stainless Steel and Non-Ferrous Metals.
 - a. Non-abrasive organic blasting media shall be utilized.
 - b. Environmental conditions shall be maximum 50% relative humidity and minimum piece and room temperature of 70 degrees F.
 - 3. Once prepared, galvanized surfaces are to be treated with Great Lakes Laboratories "Clean 'n Etch" in accordance with Manufacturer's requirements.
 - 4. Cleaned surfaces shall not remain overnight without a prime coat.
- J. Galvanized Surface Repair:
 - 1. Damaged or welded galvanized areas shall have the galvanizing repaired in accordance with the current edition of ASTM A780.
 - a. Areas shall be repaired utilizing paints containing zinc dust.
 - b. Paint shall be stirred periodically in accordance with the manufacturer's recommendations to maintain the zinc in suspension.
 - c. The repair areas shall be painted with a brush, spray painting will not be allowed.

- 2. Abraded galvanized areas shall be spot primed with a cold galvanizing compound, Tnemec 90-97 Tneme-Zinc, Carbozinc 11 HSN Carboline, Sherwin-Williams Zinc Clad 5 (aerosol), Amercoat 68MCZ or ZRC product with 95% pure zinc dust.
- 3. Spot prime all abraded galvanized areas not primed by other trades, to present a complete, protected area, to receive finish coats.
- K. Concrete and Unit Masonry Surfaces:
 - 1. Prepare cementitious substrates referencing SSPC-SP13.
 - 2. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
 - 3. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry.
 - 4. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water.
 - 5. Allow to dry.
 - 6. Application of block filler will be by roller or brush.
 - 7. Spraying will not be allowed.
- L. Ductile Iron:
 - 1. Remove grease, dirt, and other visible contaminants by washing with solvent (NAPF 500-03-01).
 - 2. Where mill scale, weld spatter, and rust are evident, remove by power tool wire brushing (NAPF 500-03-03) or where required, abrasive blast cleaning (NAPF 500-03-04 and 500-03-05).
 - 3. Spot prime paint after repairs.
 - 4. Actual surface preparation procedure shall be based on approved coating manufacturer's published recommendations.
- M. Shop Primed Steel Surfaces (Including Steel Plate Pipe):
 - 1. Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous.
 - 2. Clean surfaces with solvent.
 - 3. Prime bare steel surfaces.
 - 4. Prime metal items including shop primed items.
- N. Mechanical Equipment:
 - 1. Components to be field painted are to be pre-coated on site prior to assembly.

3.03 Application

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Allow applied coat to dry before next coat is applied.
- F. Insulated pipe, fittings and equipment without an approved surface material or color shall be painted with 2 coats of Tnemec Series 115 Uni-Bond DF, Carboline Carbocrylic 3359, Sherwin-Williams Shercryl HPA which complies with the Color Code prescribed herein.
- G. Material labels and accompanying direction of flow arrows shall be applied to all distribution mains on maximum spacing of 50 feet.
 - 1. They shall be placed at those points on all main lines where branch mains are extended therefrom, and on the distribution mains at both sides of all solid building partitions.
 - 2. Material labels and flow arrows shall be custom made for all piping systems governed by this contract, signifying the kind of material to be conducted and its direction of flow.
 - 3. Labels shall be self-adhesive and suitably coated to make them waterproof, and impervious to dirt.
 - 4. These labels shall have the identifying names superimposed on OWNER's approved background color in full or abbreviated, to meet OWNER's requirements and print the width of the label.
- H. Where letters and arrows cannot be applied to pipelines, they shall be applied to metal panels, and in a manner to agree with identification listed in the Color Code.
 - 1. Panels shall be 18 gage painted steel and hung on pipes every 50', near branch line connections and on either side of solid building partitions that pipes pass thru.
 - 2. On lines where there is flow in both directions, double arrows shall be used.
 - 3. On pipes where there is flow in one direction, single arrows shall be used.
- I. Substation equipment, control panels, panel boards, and other equipment specified to receive factory finish shall not be painted.
 - 1. However, factory painted equipment which is chipped or defaced due to handling, installation or construction activities shall be refinished in a manner satisfactory to OWNER.
 - 2. This shall include glazing, sanding, and refinishing entire surface to a suitable boundary to avoid a patched effect.
 - 3. Suitable boundaries shall be changes in planes of surfaces such as corners, frames, mouldings, recesses, etc.
- J. Hazardous areas, moving machinery, handrails, and all other similar areas shall be finished to agree with OWNER's Standard Safety Code and all MIOSHA requirements, as approved by OWNER.

3.04 Finishing Electrical Equipment

- A. Refer to Division 26 for information on electrical identification requirements.
 - 1. Refer to the end of this Section for color coding and identification banding of equipment, duct work, and piping.
- B. Paint shop primed equipment.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports.
- E. Paint dampers exposed behind louvers, grilles, to match face panels.
- F. Paint exposed conduit and electrical equipment occurring in painted areas.
- G. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
- H. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated.
 - 1. Color band and identify with flow arrows and names, to match the existing installation.
- I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 Field Quality Control

- A. CONTRACTOR shall refer to the SSPC Paint Inspection: Daily Coating Inspection Report that is a part of this section of the Specifications
 - 1. This report shall be filled out daily for every day that the painter is on site and working.
 - 2. The reports shall be filled out in their entirety as applicable for the work being performed.
 - 3. Provide multiple reports if necessary because the work for the day will include several coatings so each paint/coating type is properly documented.
 - 4. Reports shall be available to OWNER and OWNER's representative upon request at the site.
 - 5. Copies of these daily reports shall be submitted with each Payment Application for painting and coating work performed on this project for the period that is covered by the Payment Application.
 - 6. Failure to submit reports or deficient reports shall be reason to not approve the requested payment for the work.
- B. Field inspection and testing will be performed under provisions of Section 01 4500.
- C. Areas will be tested at random with dry film thickness gage.

- 1. Areas not meeting the minimum dry film thickness shown in the schedule or on approved Shop Drawing submittals shall have additional coats applied so the minimum dry film thickness is achieved.
- 2. Each coat shall achieve the minimum dry film thickness specified, without regards to the overall system thickness.
- D. If an existing surface or area is not called out for painting but is defaced or damaged due to new Work under this Contract, then this surface or area shall be repainted to match adjacent areas, at no additional cost to OWNER.
 - 1. Repair areas shall be to a suitable area boundary as determined by ENGINEER in the field.
 - 2. A repaired area may include an entire wall or the entire floor in a room or gallery.
 - 3. Patched effect repairs shall not be acceptable.

3.06 Cleaning

- A. Clean work under provisions of Section 01 7700, Closeout Procedures.
- B. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
- C. Make good all damage done to floors and other work through neglect or carelessness or from failure to properly protect work from damage resulting from the execution of this work.

3.07 Schedule - Interior and Exterior Surfaces

| Paint System | Surfaces |
|--------------|---|
| 1 | Exterior/Interior Ferrous Metals, Piping and Equipment (Including Steel Plate Pipe) |
| 3A | Interior Masonry Units |
| 3B | Interior exposed precast and poured in place concrete, including interior concrete wall surfaces below grade (not specified elsewhere). |
| 6 | Submerged Ferrous Mechanical Equipment Components and Piping |
| 8 | Exterior Wood |

- A. Painted walls, without applied base, shall be scribed 4 inches and painted with a 4-inch high, gloss black base.
 - 1. Material for base shall be compatible with the wall material.
- B. Aluminum Surfaces shall be back-coated with an OWNER approved epoxy/sealer. Refer to paragraph 3.2.E of this Section.

3.08 Painting - Systems

See Next Pages for Paint Systems

- A. Paint System No. 1 Exterior/Interior Ferrous Metals, Piping and Equipment:
 - 1. Surface Preparation, Ductile Iron Pipe NAPF 500-03-04
 - 2. Surface Preparation, Ductile Iron Valves and Fittings NAPF 500-03-05
 - 3. Surface Preparation, Galvanized Steel SSPC-SP 16 and Clean 'n Etch
 - 4. Surface Preparation, Existing Historic Steel Window Frames SSPC-SP2 Hand Tool Cleaning (to prevent further damage to assemblies)
 - 5. Surface Preparation, All Other Surfaces (Including New and Existing Steel Plate Pipe) SSPC-SP 6, except primed surfaces. Touchup new primed pipe as necessary.

| Layer | Min. No. of Coats per Coating Layer | Product Name | Min. Total Thickness of Coating Layer Dry | Туре |
|--|--|--|--|------------------------------------|
| Primer | 1 | Tnemec Series N69 | 3.0 | Polyamide Epoxy |
| Intermediate | 1 | Tnemec Series N69 | 4.0 | Polyamide Epoxy |
| Finish | 1 | Tnemec 1075 Endura Shield | 3.0 | Aliphatic/ Acrylic Polyurethane |
| Primer | 1 | Carboline 890 | 3.0 | Cycloaliphatic Amine Epoxy |
| Intermediate | 1 | Carboline 890 | 4.0 | Cycloaliphatic Amine Epoxy |
| Finish | 1 | Carboline 134 HG | 3.0 | Aliphatic/Polyurethane |
| Primer | 1 | Sherwin-Williams Macropoxy 646 | 3.0 | Ероху |
| Intermediate | 1 | Sherwin-Williams Macropoxy 646 | 4.0 | Ероху |
| Finish | 1 | Sherwin-Williams Acrolon 218 Or Hi-Solids Polyurethane | 3.0 | Aliphatic/Polyurethane |
| CONTRACTOR shall choose one of Primer-Intermediate-Finish systems listed above. Total Thickness of System – 11.0 Dry Mils Min. CONTRACTOR shall note curing times required between coats, per actual product used. | | | | |

B. Paint System No. 3A - New Interior Masonry Units:

| Layer | Min. No. of Coats per Coating Layer | Product Name | Min. Total Thickness of Coating Layer Dry | Туре |
|---|--|--|--|---|
| Undercoat | 1 | Tnemec 130-6602 Envirofill | 60-80 s.f. gal. | Waterborne Cementitious Acrylic |
| Primer | 1 | Tnemec Series N69 Epoxoline | 4.0 | Polyamide Epoxy |
| Finish | 1 | Tnemec 1075 Endura Shield | 4.0 | Aliphatic/ Acrylic Polyurethane |
| Undercoat | 1 | Carboline Sanitile 500 Block Filler | 60-100 s.f. gal. | Water Based Epoxy Filler |
| Primer | 1 | Carboline Carboguard 890 | 4.0 | Cycloaliphatic Amine Epoxy |
| Finish | 1 | Carboline Carboguard 134 HG | 4.0 | Aliphatic Polyurethane |
| Undercoat | 1 | Sherwin-Williams Cement-Plex 875 | 60-100 s.f. gal. | Cementitious Waterborne Block filler |
| Primer | 1 | Sherwin-Williams Macropoxy 646 | 4.0 | Polyamide Epoxy |
| Finish | 1 | Sherwin-Williams Acrolon 218 | 4.0 | Aliphatic Polyurethane |
| CONTRACTOR shall choose one of the Undercoat-Primer-Finish systems listed above. Total Thickness of System –8.0 Dry Mils Minimum over filled surface. | | | | |

1. Surface Preparation - SSPC-SP 13/NACE 6.

C. Paint System No. 3B - Interior Exposed Precast and Poured In Place Concrete:

- 1. Surface Preparation Same as above
- 2. Primer and Finish Same as above, but without Undercoat
- 3. Total Thickness of System 6.0/8.0 Dry Mils Min.
- D. Paint System No. 6 Submerged Ferrous Mechanical Equipment Components and piping (non-potable)

| Layer | Min. No. of Coats per Coating Layer | Product Name | Min. Total Thickness of Coating Layer Dry | Туре |
|------------------------|--|------------------------------------|--|-------------------------------|
| Finish | 1 | Hi-Build Tnemec - Tar 46H - 413 | 18.0 | Coal Tar Polyamide Epoxy |
| Finish | 1 | Carboline Bitumastic No. 300M | 18.0 | Coal Tar Polyamide Epoxy |
| Finish | 1 | Sherwin-Williams Targuard | 18.0 | Coal Tar Polyamide Epoxy |
| CONTRACTOI Minimum. | R shall choose o | ne of the systems listed abov | e. Total Thickne | ess of System – 18.0 Dry Mils |

1. Surface preparation - SSPC-SP10:

- 1. Surface Preparation Surfaces must be clean, dry and free of contaminants and loose paint in accordance with Manufacturer's recommendations.
- 2. Provide Satin or Semi-gloss sheen for Finish coat.

| Layer | Min. No. of Coats per Coating Layer | Product Name | Min. Total Thickness of Coating Layer Dry | Туре |
|--|--|--|--|--|
| Primer | 1 | Tnemec Series 151-1051 Elasto-Grip FC | 2.0 | Waterborne Modified Polyamine Epoxy |
| Finish | 2 | Tnemec Series 156 Enviro-Crete | 5.0 | Modified Waterborne Acrylate |
| Primer | 1 | Carboline Sanitile 120 | 2.0 | Waterborne Acrylic |
| Finish | 2 | Carboline Flexxide Elastomer | 5.0 | Acrylic-Copolymer Elastomeric |
| Primer | 1 | Sherwin Williams Exterior Latex Wood Primer | 2.0 | - |
| Finish | 2 | Sherwin-Williams Loxon XP | 5.0 | - |
| CONTRACTOR shall choose one of Primer-Finish systems listed above. Total Thickness of System – 12.0 Dry Mils Minimum. | | | | |

3.09 Schedule - Equipment Colors

A. Refer to Section 09 1000, Piping Identification System, for color and identification requirements.

See Sample Daily Coating Inspection Form on Next Page

| Paint Inspection: | Date: / / MTWThFSS | u Pg. Of |
|--|---|------------------------|
| ranit inspection. | Project #: | COPY To: |
| Daily Coating Inspection Report | Inspector: | QC Mgr D Owner |
| Project/Client: | | Contr |
| Location: | | Attachments: |
| Description: | | DFT Sheet D NCR/CAR |
| Requirements: | | P |
| Contractor: | Spec # | Revision # |
| Description of Areas & Work Performed | Hold Point Inspection | is Performed |
| | 1 Pre Surface Pep/Condition 8 | k Cleanliness |
| | 2 Surface Preparation Monitor | ing |
| | 3 Post Surface Preparation/Cl | eanliness & Profile |
| | 4 Pre Application Prep/Surface | e Cleanliness |
| | 5 Application Monitoring/Wet F | -ilm Thickness (WFT) |
| | 6 Post Application/Application | Defects |
| | 7 Post Cure/Dry Film Thicknes | ss (DFT) |
| | 8 Nonconformance/Corrective | Actions Follow-up |
| | | |
| Surface Conditions | Approved By: | litions |
| | Timo, autori du put | |
| | | · · · · |
| | | 0 0 0 |
| Degree of contamination: | % Belative Humidity % | 0/ 0/ 0/ |
| Test: Cl ug/cm² / nom Ee nom DhH | Surface Temp ⁰ (C/E) Min/May / ° | |
| | Dew Point Temp ⁰ (OF) | 0 0 0 |
| Scale Pitting/Holes Crevices Sharp Edges | Wind Direction/Speed | |
| | Weather Conditions: | |
| Painted Surface Condition: | Applicatio | on |
| Drv to: Touch Handle Recoat | Start Time : Finish Time : | Est. Sa/ft. |
| Dry/Over Spray Runs/Sags Pinholes Holidays | Primer Intermediate To | opcoat D Touch-up |
| Abrasion Fall Out Other | Generic Type: Qt | ty Mixed: |
| Surface Preparation | Manuf.: Mi | ix Ratio: |
| Start Time: Finish Time: Est Sq/ft: | Prod Name: Mi | ix Method: |
| Solvent Clean Hand Tool Power Tool | Prod #: St | train/Screen: |
| HP Wash PSI Other | Color: Ma | aterial Temp: °F |
| Abrasive Blast Abrasive Type Sample | Kit Sz/Cond.: Sv | weat-in Time: Min/Hrs |
| Blast Hose Size Nozzle Size / PSI | Shelf Life: Po | ot Life: Min/Hrs |
| Air Supply CFM Air Supply Cleanliness | Batch #'s Re | educer #: |
| Water/Oil Trap Check D Equipment Condition Check | (A) Q1 | ty Added: Pt/Qt/Gal |
| | (B) % | by Vol: % |
| Surface Cleanliness & Profile Measurement | (C) Sr | pecified WFT Avg: Mils |
| Job Specification SSPC/NACE - SP- | Reducer: Ac | chieved WFT Avg: Mils |
| SSPC/NACE Spec / Visual Stds | Airless/Conv. Spray Brush Ro | ller Other |
| Profile Check: Disc Tape Gauge | Pump Pot Hose Dia. | Air Check |
| Specifiedmils avg. / Achievedmils | Ratio/Size Hose Lng. | SEP/Trap |
| Surface effect on DFT Gauge/BMRmils | GPM/CFM Spray Gun | Filter |
| | Tip Sz. | Agitator |
| Gage Type / Gage Gage Calio. Spec Avg. Total Avg DFT Last Coat Verified DFT DFT Coat | | |
| | Inspector's Signature | Date |
| | | Created 03/03 by |

(SSPC The society for protective coatings

Division 26 Electrical

Section 26 0500 Common Work Results for Electrical

Part 1 General

1.01 Section Includes

A. General electrical equipment and installation requirements.

1.02 Work Included

- 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 1-2010, Good Workmanship in Electrical Contracting.
- 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.

1.03 Description of Systems

- A. Existing medium voltage power for the pump shall be 4160 volts, 3 phase, 3 wire plus ground, supplied from the existing medium voltage VFD.
- B. Existing secondary power shall be 480 volts, 3 phase, 3 wire plus ground, 60 Hertz supplied from the existing MCC.
- C. Lighting system shall be 120/208 volts, 3 phase, 4 wire plus ground, 60 Hertz supplied from the existing lighting panel.

2.01 Materials and Equipment

- 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. Modifications to existing Variable Frequency Controllers
 - 2. Electrical Equipment and Devices
 - 3. Raceway System
 - 4. Power Feeder and Branch Circuit Wiring
 - 5. Modifications to Existing Motor Control Centers
 - 6. Disconnect Switches
 - 7. Surge Protection Devices
 - 8. 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 lamps

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-2015 and IEEE Standard 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/cm²) 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.

- G. In the protective devices coordination analysis, provide time-current curves graphically indicating the coordination proposed for the system, including ground fault protection, centered on conventional full-size log-log paper. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portions of the system covered by that particular curve sheet. Each curve sheet shall display curves for a maximum of four (4) protective devices. Include a detailed description of each protective device identifying type, function, and degree of coordination achieved. Tabulate recommended device pick-up, instantaneous, and time delay settings.
- H. Include on the curve sheets low voltage equipment circuit breaker trip device and fuse characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include devices down to the low voltage feeder breakers. Include transformer destruct curves (ANSI method; including thermal and mechanical stress limits) and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- I. The short circuit, flash hazard, and protective devices coordination analyses may be prepared with a digital computer or by written calculations but must include complete fault tabulations from the sources shown on the Drawings. Obtain the existing analyses for the existing portions of the plant's electrical distribution from OWNER, as a basis for the additions and modifications.
- J. The short circuit, flash hazard, and protective devices coordination analyses shall be provided by an electrical power distribution equipment manufacturer or an electrical distribution systems analyst. Analyses shall be prepared by persons experienced in the work.
- K. The Drawings and Specifications indicate the general requirements for the electrical equipment being provided. Changes and additions to equipment characteristics may be suggested by the results of the short circuit, flash hazard, and protective devices coordination analyses. Submit any such proposed changes and additions as a part of the analyses document. Necessary field settings of devices, adjustments, and modifications to equipment to accomplish conformance with the approved short circuit, flash hazard, and protective devices coordination analyses shall be carried out by the particular manufacturer or by CONTRACTOR at no additional cost to OWNER. Required field settings and adjustments shall be made on existing protective devices also.

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.

Section 26 0510 Basic Electrical Materials and Methods

Part 1 General

1.01 Scope of Work

A. Requirements specified in Section 26 0500, 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 03 3000: Cast-in-Place Concrete
- B. Section 26 0500: 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 0500, Electrical General Requirements.

Part 2 Products

2.01 Basic 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 Eaton, Square D Co., or Allen Bradley.
- 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 "NQOB", G.E. NLAB, 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, type THHN, THW, XHHW or THWN, insulated with Underwriters approved 600-volt insulation, and in accordance with the following:

- 2. 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.
- 3. Thermoplastic insulated wire and cable shall be manufactured and tested in accordance with ICEA Publication No. S-61-402 (latest edition), NEMA Publication WC5.
- 4. 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.
- 5. 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.
- 6. Type "XHHW" heat resistant wire shall be used for wiring of recessed fixtures, and between fixtures and their adjacent outlets.
- 7. For 480 volt standard service, single conductor stranded copper cable shall have corona, ozone, heat and moisture resistant cross-linked polyethylene 600 volt insulation, or approved equal, rated to withstand a copper temperature of 90°C. without deterioration. It shall meet applicable ICEA Standards, and be UL labeled XHHW.

| 8. | Wire and cable, including feeders, main and branch circuits, shall be color coded |
|----|---|
| | as follows: |

| 208 / 1 | 20 Volt | 480 / 27 | 7 Volt |
|---------|---------|----------|---------|
| Color | Phase | Color | Phase |
| Black | А | Brown | А |
| Red | В | Orange | В |
| Blue | С | Yellow | С |
| White | Neutral | Gray | Neutral |
| Green | Ground | Green | Ground |

- 9. 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.
- 10. 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, Triangle, or equal.
- 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. The insulation shall be a 20-mil wall of polyethylene with a 10-mil thick polyvinyl chloride jacket. The 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. 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°F. 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. This 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 and intermediate 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.
- 10. Conduits installed in "hazardous areas" shall be approved for the Hazardous Class Division and Group as required by NEC and identified on the drawings.
- 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 4 for outside use where exposed to the weather or where otherwise called for on the drawings.
 - 2. Pull boxes located in "hazardous areas" shall be in strict accordance with National Electric Code requirements for the type of area classification and as identified 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.
 - 4. Outlet boxes installed in hazardous areas shall be approved for the Hazardous Class, Division and Group as required by NEC and identified on the drawings.
- 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 or equal. 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.
- M. Switch and Receptacle Plates:
 - 1. 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.
 - 2. Cadmium plated steel plates shall be installed in equipment space and process areas.
 - 3. Grouped devices shall be mounted in a single continuous gang plate.
- N. Lighting Fixtures:
 - 1. CONTRACTOR shall furnish all materials and equipment required to install and place in operation 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 Lithonia model FEM L48 3000LM IMACD MD MVOLT GZ10 40K 80CRI WLFEND2. 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. Underwriters Labels: Fixtures, signs, etc., shall carry the approval of Underwriters Laboratories, Inc., and be so labeled.
- 0. Lamps:
 - 1. CONTRACTOR shall furnish and install lamps for types of lighting fixtures as shown on the Schedules and Drawings. Fixtures shall be cleaned, and all lamps shall be relamped at the end of the job. See Article 3.05 for adjustment and cleaning.

- 2. Led lamp color temperature shall be, 4000 degrees Kelvin. The initial light output shall be 3,000 lumens.
- P. Ballast:
 - 1. Ballast shall be an integral part of the fixtures as specified on the drawings.
 - 2. Ballasts shall be high power factor, non-PCB, E.T.L. certified and shall carry Certified Ballast Manufacturer's and Underwriters Laboratories' labels.
- Q. Motor Starters:
 - 1. 3-Phase Starters:
 - a. Starter for each 3-phase single speed motor shall be on the nonreversing across the line combination magnetic type, minimum size 1 with magnetic circuit breaker and control transformer.
 - b. Circuit breaker shall be externally operated, interlocked to prevent opening the cover when the switch is closed.
 - c. Starter shall have, in addition to a holding circuit contact, two auxiliary contacts.
 - d. Control transformer shall be rated 480 volts to 120 volt with fused secondary, minimum 50 VA but of sufficient capacity to service the starter coil plus such auxiliaries as may be indicated. Each starter shall be provided with wiring and schematic control diagrams which applies to the unit it serves.
 - 2. Single Phase Starters:
 - a. Starters for single phase motors shall be manual type, with overload protection and on-off switch.
- R. 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. Nameplate 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).

2.02 Mixes

A. Patches, conduit sealing compound, fire stop compounds, etc., shall be mixed in accordance with the manufacturer's recommendations.

2.03 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.

2.04 Equipment

- 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.

2.05 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.

Part 3 Execution

3.01 Contractor's 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 underground conduits on the site in accordance with the drawings and CONTRACTOR 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. Hazardous Locations:
 - 1. Equipment, fittings, and wiring installed in hazardous areas, shall be approved by the N.E.C. for respective class and division which is applicable to area(s) where installed.
 - 2. Sealing fittings shall be properly installed at all required locations in accordance with code regulations. Automatic drain conduit seals shall be used wherever necessary to ensure the prevention of moisture accumulation. Approved breathers shall be installed in appropriate locations.
- C. 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 NEC.
- D. 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.
- E. 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.

- F. Lighting:
 - 1. Lighting fixtures shall be mounted level at the height as indicated on the Drawings.
- G. 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.
- H. 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.

- I. 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.
- J. 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 panels required for access to his work. CONTRACTOR shall install 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 with serve all and eliminate additional panels.
- K. 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, Penn-Union Electric Company, or equal.
- (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 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. 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.
- L. 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.
- M. 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. Tests 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 insulation tests shall be furnished to ENGINEER.

3.05 Adjustment 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 instrumentation and other major equipment.

- C. Cleaning and Finishing:
 - 1. Before turning the systems over to OWNER, clean fixtures, equipment, exposed metal surfaces, and leave 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.

Part 1 General

1.01 Section Includes

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0705: Electrical Test Certificates

1.03 References

A. ANSI/NFPA 70 - National Electrical Code.

1.04 Grounding Electrode System

- A. Metal underground utility piping.
- B. Metal frame of the building.
- C. Ground loops, risers, and conductors.
- D. Rod electrodes.
- E. Ground mat.

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 under Section 16960, Electrical Testing and Equipment.

1.06 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Product Data: Provide data for grounding electrodes and connections.
- C. Test Reports: Indicate facility's overall resistance to ground.
- D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.07 **Project Record Documents**

A. Submit under provisions of Section 01 7700, Closeout Procedures.

B. Accurately record actual locations of grounding electrodes.

1.08 Regulatory Requirements

- A. Conform to requirements of ANSI/NFPA 70.
- 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 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.
Section 26 0529 Hangers and Supports for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.02 References

- A. NECA National Electrical Contractors Association.
- B. ANSI/NFPA 70 National Electrical Code.

1.03 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- 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.

1.04 Regulatory Requirements

- A. Conform to requirements of ANSI/NFPA 70.
- 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 **Product 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 indicated elsewhere in Division 16. 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-torqueing.
- 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 or 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. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- I. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.
- J. 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.
- K. The use of wood plugs for anchoring raceways, cabinets, enclosures, or equipment to concrete or masonry will not be permitted.
- L. CONTRACTOR shall provide and install, where required, the additional steel to adequately support all conduits, boxes, and all other electrical equipment.
- M. All 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.
- N. 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.
- O. All 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 Section 26 0533.23, 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 0533.13 Underground Conduit System

Part 1 General

1.01 Section Includes

A. Direct buried conduit.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0533-23: Surface Raceways for Electrical Systems

1.03 References

- A. ANSI C80.5 Rigid Aluminum Conduit.
- B. UL 6 Standard for Rigid Metal Conduit.
- C. ANSI/ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- D. ANSI/ASTM A569 Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- E. ANSI/IEEE C2 National Electrical Safety Code.
- F. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- G. ANSI/NFPA 70 National Electrical Code.
- H. ASTM A48 Gray Iron Castings.
- I. ASTM A123 Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
- J. NEMA TC 2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- K. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- L. NEMA TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation.
- M. NEMA TC 7 Smooth Wall Coilable Polyethylene Electrical Plastic Duct.
- N. NEMA TC 8 Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
- O. NEMA TC 9 Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
- P. NEMA TC 10 PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
- Q. NEMA TC 14 Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes and handholes.
- C. Shop Drawings: Indicate dimensions, reinforcement, size, and routings of underground ducts and duct banks.
- D. Product Data: Provide for metallic conduit; non-metallic duct, conduit, and duct fittings; manhole and handhole accessories, frames, and covers.
- E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.05 Project Record Documents

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures and Section 01 7700, Closeout Procedures.
- B. Accurately record actual locations of exact routing of duct banks and underground conduit runs.
- C. Accurately record actual locations of each manhole and handhole.

1.06 Regulatory Requirements

- A. Conform to requirements of ANSI/NFPA 70.
- B. 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.

1.07 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.08 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 0533.
- 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. Carlon
 - 2. JM Eagle
 - 3. Robintech
 - 4. 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.

2.04 Non-Metallic, FRP Duct

- A. Manufacturers:
 - 1. FRE Composites, Inc.
 - 2. A. O. Smith/Inland
 - 3. Champion Fiberglass
- B. Conduit and Fittings: NEMA TC 14; Type SW or HW. Fittings and adapters shall be as supplied by the duct manufacturer.
- C. Joining Method: Tapered bell and spigot joints.

2.05 High Density Polyethylene (HDPE) Conduit

- A. Manufacturers:
 - 1. Dura-line
 - 2. Carlon
- B. 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 nonmetallic 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 0533.16 Boxes for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.
- C. Wireways.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical Systems
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0529: Hangers and Supports for Electrical Systems
- D. Section 26 0553.13: Conduit for Electrical Systems
- E. Section 26 0533.23: Surface Raceways for Electrical Systems
- F. Section 26 0553: Electrical Identification
- G. Section 26 2716: Electrical Cabinets and Enclosures
- H. Section 26 2726: Wiring Devices

1.03 References

- A. NECA Standard of Installation.
- B. NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies.
- C. NEMA OS 1 Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. NEMA OS 2 Non-metallic 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 shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Shop Drawings: Indicate materials, finishes, dimensions, listings, and standards compliance.
- C. Product Data: Provide data for boxes, wireways, and accessories.
- D. 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, and installation of Product.

1.05 Submittals for Closeout

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures, and Section 01 7700, Closeout Procedures.
- B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 Regulatory Requirements

- A. Conform to requirements of NFPA 70, National Electrical Code.
- B. 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.
- C. 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 feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2716.
- E. Covers for boxes containing wiring devices shall be as specified in Section 26 2716.
- 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.

2.02 Pull and Junction Boxes

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 2716
- 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 Type 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 0553
- 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; condulet 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 2716.
- 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.
- 0. 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

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

3.04 Cleaning

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

End of Section

Section 26 0533.23 Surface Raceways for Electrical Systems

Part 1 General

1.01 Section Includes

- A. Metal conduit.
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Non-metallic conduit.
- E. Flexible non-metallic conduit.
- F. Fittings and conduit bodies.

1.01 Related Sections

- A. Section 26 0500: Common Work Results for Electrical Systems
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0529: Hangers and Supports for Electrical Systems
- D. Section 26 0526: Grounding and Bonding for Electrical Systems
- E. Section 26 0529: Hangers and Supports for Electrical Systems
- F. Section 26 0533.13: Underground Conduit System
- G. Section 26 0533.16: Boxes for Electrical Systems
- H. Section 26 0553: Identification for Electrical Systems
- I. Section 26 0700: Wire and Cable
- J. Section 26 0705: Electrical Testing and Equipment

1.02 References

- A. ANSI C80.5 Rigid Aluminum Conduit.
- B. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- C. ANSI/NFPA 70 National Electrical Code.
- D. NECA 101-2013, Steel Conduits (Rigid, IMC, EMT).
- E. NECA 111-2003, Standard for Installing Non-metallic Raceways.
- F. NEMA RN 1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- G. NEMA TC 2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- H. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- I. UL 6 Standard for Rigid Metal Conduit.

1.03 Submittals

A. Submit in accordance with Section 01 3300, Submittal Procedures.

- B. Shop Drawings: Indicate materials, finishes, dimensions, listings, and standards compliance.
- C. Product Data: Provide data for conduit, tubing, duct, fittings, and accessories.
- D. 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, and installation of Product.

1.04 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle Products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept conduit on site. 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.

1.05 **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 regerence 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 steel 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; steel 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 insure 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 Non-Metallic, FRP Conduit and Fittings

- A. Manufacturers:
 - 1. FRE Composites, Inc.
 - 2. A.O. Smith/Inland
 - 3. Champion Fiberglass
- B. Conduit and fittings: NEMA TC 14; Type SW or HW. Fittings and adapters shall be as supplied by the duct manufacturer.

C. Joining method: Tapered bell and spigot joints.

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 insure 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 of Raceways

- 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 0553, Identification for Electrical Systems.
- 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 0529, 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.
- 0. 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.

Other conduit bends shall conform to the following: 2-inch and 2-1/2-inch conduit, 24inch 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.

- Y. 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.
- Z. 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.
- AA. 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.
- BB. 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.

- CC. Metallic sleeves containing a ground conductor shall be bonded at each end to the ground conductor.
- DD. The ends of metallic conduits or elbows shall be cut square, reamed and threaded.
- EE. 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.
- FF. 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.
- GG. Ground and bond metallic raceway systems under provisions of Section 26 0526, Grounding and Bonding.
- HH. 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.
- II. 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.
- JJ. 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.
- KK. Sealing fittings and other fittings for conduit in hazardous locations shall be explosion proof, Class I, Division 1, Group D.
- LL. Electrical metal tubing or so called "Thin Wall" conduit and fittings shall not be used.
- MM. Raceway systems, in general, shall consist of Rigid Metal Conduit and fittings or nonmetallic, FRP Conduit and fittings.
- NN. 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.
- OO. 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.
- PP. 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.
- QQ. Flexible conduit may be used only where rigid conduit is impracticable or where indicated on the Drawings.
- RR. Liquidtight, 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.
- SS. 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.
- TT. 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.
- UU. Flexible metallic conduit may be used for final connections to lay-in fluorescent lighting fixtures.
- VV. Plastic (PVC) conduit may be used only where indicated on the Drawings.
- WW. Install non-metallic conduit in accordance with manufacturer's instructions.
- XX. 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 0553 Electrical Identification

Part 1 General

1.01 Section Includes

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

1.02 Related Sections

A. Section 09 9000: Painting and Coating

1.03 References

A. ANSI/NFPA 70 - National Electrical Code.

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Product Data: Provide catalog data for nameplates, labels, signs, diagrams, and markers.
- 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 and installation of Product.

1.05 Regulatory Requirements

A. Conform to requirements of ANSI/NFPA 70.

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:
 - Flash Hazard Boundary
 cal/cm2 Flash Hazard at 18 inches
 PPE ______
 Shock Hazard When Cover is ______
 Limited Approach
 Restricted Approach ______
 Equipment Name: _______
- 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. All other nameplates shall be engraved as follows and shall be included on nameplate schedules submitted to the Owner for approval:
 - a. First Line: Process description, equipment served, or area served (if applicable).
 - b. Second Line: Equipment or device description.

- c. Third Line: Equipment or device designation number and power source circuit number.
- d. 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 0705, 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 0700 Wire and Cable

Part 1 General

1.01 Section Includes

- A. Building wire.
- B. Underground feeder and branch circuit wire.
- C. Instrumentation cable.
- D. Communications cables.
- E. Wiring connectors and connections.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0529: Hangers and Supports for Electrical Systems
- C. Section 26 0533.13: Underground Conduit System
- D. Section 26 0533.16: Boxes for Electrical Systems
- E. Section 26 0533.23: Surface Raceways for Electrical Systems
- F. Section 26 0553: Electrical identification

1.03 References

- A. ANSI/NFPA 70 National Electrical Code (NEC)
- B. Underwriters' Laboratories Standard UL-83
- C. Underwriters' Laboratories Standard UL-44
- D. Federal Specification A-A-59544
- E. ANSI Standard C33.80
- F. ICEA Insulated Cable Engineers Association
- G. ASTM American Society for Testing and Materials

1.04 Submittals

- A. Shop drawings shall be submitted in accordance with Section 01 3300, Submittal Procedures.
- B. Product Data: Provide for all wire and cable.
- 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. Coordinate Work under provisions of Section 01 3119, Project Meetings.
- B. Determine required separation between cable and other work.
- C. 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 Manufacturers – Building Wire

- A. General Cable
- B. Southwire Corporation

2.03 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.

2.04 Manufacturers – Underground Feeder and Branch-Circuit Wire

- A. General Cable
- B. Southwire Corporation

2.05 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.

2.06 Manufacturers – Instrumentation Cable

- A. Single Pair Cable:
 - 1. Belden No. 8760
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C2534.
- B. Multiple Pair Cable:
 - 1. Belden No. 9773 through No. 9777
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C6047-C6051.
- C. Three Conductor Cable:
 - 1. Belden No. 8770.
 - 2. Southwire Corporation
 - 3. General Cable/Carol Brand No. C2535.

2.07 Instrumentation Cable

- A. Description, general:
 - 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.
 - b. Multiple pair cable polyethylene or polypropylene.
 - c. Three conductor cable polyethylene.
 - 4. Shield material: 100 percent aluminum polyester.
 - 5. Drain wire: Stranded, tinned copper.
 - 6. Jacket: Chrome vinyl (PVC).
- C. Riser and Plenum Use Cables:
 - 1. 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.

2.08 Manufacturers – Communications Cable

A. 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.

B. 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.

2.09 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:
 - 1. 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.

2.10 Manufacturers – Wiring Connectors and Associated Materials

- A. Solderless Pressure Connectors:
 - 1. 3M[™] Company Model Scotchlok
 - 2. Thomas & Betts Model Sta-Kon
 - 3. Burndy Model Insulug Type TN
- B. Spring Wire Connectors:
 - 1. 3M[™] Company Model Scotchlok
 - 2. Ideal Model Wing-Nut
- C. Compression Connectors:
 - 1. 3M[™] Company Model Scotchlok
 - 2. Thomas & Betts Model Color-Keyed
 - 3. Burndy Model Hylug
- D. Tap Connectors:
 - 1. Thomas & Betts Model Color-Keyed
 - 2. Burndy Model Crimpit
 - 3. Anderson Model Crimptaps
- E. Watertight, Twist-On Connectors:
 - 1. 3M[™] Company Direct Bury Splice Kits
 - 2. King Innovation "DryConn"
 - 3. Ideal Industries, Inc. Twister DB Plus
- F. Watertight, Insulated Connector Blocks:
 - 1. Utilco Type USPA-SS, Type PSA-SS, or Type PED-SS
 - 2. Ilsco Type USPA-SS
- G. Electrical Insulating Tape:
 - 1. 3M[™] Company "Scotch" No. 33+
 - 2. Plymouth "Premium Black"

- H. High Temperature Tape:
 - 1. 3M[™] Company "Scotch" No. 70
 - 2. Plymouth "Plysil"
- I. Fireproofing Tape:
 - 1. 3M[™] Company "Scotch" No. 77
 - 2. Plymouth No. 50
- J. Woven Fiberglass Tape:
 - 1. 3M[™] Company "Scotch" No. 69
 - 2. Plymouth "Plyglas"
- K. Color Coding Tape:
 - 1. 3M[™] Company "Scotch" No. 35
 - 2. Plymouth "Slipknot" No. 45
- L. Insulating and Watertight Sealing Materials:
 - 1. 3M[™] Company "Scotchcast" kits
 - 2. Raychem WCS Series heat shrinkable sleeves
 - 3. 3M[™] Company 8400 Series cold shrink materials
 - 4. 3M[™] Company "Scotchkote" sealant
- M. Watertight Cord Grip Fittings:
 - 1. Crouse-Hinds CGB-SG Series
 - 2. Appleton Electric Co.
 - 3. Thomas & Betts
- N. Cable or Cord Strain Relief:
 - 1. Hubbell-Kellems
 - 2. Daniel Woodhead Co.
- 0. Cable Pulling Lubricant:
 - 1. American Polywater "Dyna-Blue"
 - 2. Ideal "Aqua Gel"
 - 3. Minerallac "Golden Glide"
 - 4. 3M[™] Company "GEL"

2.11 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.

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.
- 0. 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 0533.23.
- 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. All 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; condulet 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 0553, 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 0553, Identification of Electrical Systems.
- 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 4500, Quality Control and 26 0705, 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 0705 Electrical Testing and Equipment

Part 1 General

1.01 Section Includes

- A. Division 26 testing requirements.
- B. Test equipment requirements.
- C. Sample forms.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 26 0500: Common Work Results for Electrical
- C. Section 26 0510: Basic Electrical Materials and Methods
- D. Section 26 0800: Commissioning of Electrical Systems

1.03 References

- A. All 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. All 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. Submit on Products under provisions of Section 01 3300, 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.

1.05 Project Record Documents

A. Submit test results under provisions of Section 01 7700, Closeout Procedures.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 7900, Demonstration and Training.
- B. Operation Data: Include bound copies of operating and programming instructions.
- C. 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).

1.07 Qualifications

- 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 onsite crew leader shall hold a current certification, Level III or higher, in electrical testing.

1.08 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.

1.09 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage. Turn over to OWNER immediately.

Part 2 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. Testing of package equipment shall be as required in other Sections.

B. 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 trouble-shooting and repair/replacement procedures.

End of Section

Section 26 0705.10 Electrical Test Certificates

See following pages for individual Certifications

Cable Test Certificate

| 1.0 | TECHNICIAN I | | Contact Pers | Contact Person | | | |
|-----|-----------------|---------------------|---------------------|-------------------|--|--|--|
| | Address: | | Phone No.: _ | | | | |
| 2.0 | CABLE IDENT | IFICATION | | | | | |
| | Cable Designat | ion or Circuit No.: | | | | | |
| | Cable Source _ | | _ Air Temperature _ | | | | |
| | Termination Po | oint | _ Humidity | | | | |
| | Connected Equ | ipment | _ Equipment Temper | rature | | | |
| | Test Voltage | No. of (| Conductors | Age | | | |
| | Length | Size | | Operating Voltage | | | |
| | Cable Type | Rated | Voltage | Ground Type | | | |
| | Manufacturer | | Insulation Type | | | | |
| | Insulation Thic | kness | | | | | |
| | Conductor Mat | erial | _ | | | | |
| | | <u>Phase C</u> | olor Identification | | | | |
| | Phase A: | Phase D | B: | Phase C: | | | |
| 3.0 | TEST INSTRU | MENT | | | | | |
| | Manufacturer_ | | Model No | | | | |
| 4.0 | POWER CABL | E TEST – MEGGER TE | ST | | | | |
| | Time | Phase A Megohms | Phase B Megohms | Phase C Megohms | | | |

| Time | Phase A Megohms | | Phase B | Megohms | Phase C Megohms | | |
|---------|-----------------|-------|---------|---------|-----------------|-------|--|
| Minutes | Before | After | Before | After | Before | After | |
| | | | | | | | |
| .25 | | | | | | | |
| .50 | | | | | | | |
| .75 | | | | | | | |
| 1.00 | | | | | | | |
| 1.25 | | | | | | | |
| 1.50 | | | | | | | |
| 1.75 | | | | | | | |
| 2.00 | | | | | | | |
| 2.25 | | | | | | | |
| 2.50 | | | | | | | |
| 2.75 | | | | | | | |
| 3.0 | | | | | | | |
| 4.0 | | | | | | | |
| 5.0 | | | | | | | |

5.0 CERTIFICATION

6.0

I certify that the above information is correct and that the cable installation and condition conform to manufacturer and Contract Specification requirements, unless otherwise noted.

| Technician Signa | | | | | | |
|------------------|----------|---------------------|--|-------|--|--|
| ENGINEER REVIEW | | | | | | |
| Test Witnessed: | □Yes □No | Reviewer Signature: | | Date: | | |

Instrument Calibration Certificate

| 1.0 | INSTRUMENT IDENTIFICATION Tag Number Instrument Name DCS Point Reference Manufacturer Model Number Part Number Cal. Range Serial Number | |
|-----|--|----------------------|
| 2.0 | CALIBRATION / TEST EQUIPMENT IDENTIFICATION Description Manufacturer Model Number Part Number Serial Number Calibration Date Accuracy | |
| 3.0 | INSTRUMENT INSTALLATIONInstalled per manufacturers instructions:YesInstalled per Contract Specifications:YesDiscrepancy DescriptionWiring Continuity from Instrument to Instrument:N/AWiring Continuity from Instrument to RIO Cabinet:N/A | No No OK OK |
| 4.0 | INSTRUMENT CALIBRATION – ANALOG / DIGITAL Level Input Units Value at Indicator Value at DCS/PLC 0 % | |
| | SettingDeadbandActivation at DeviceActivationPoint 1Point 2Point 3 | <u>on at DCS</u> |
| 5.0 | INSTRUMENT ADJUSTMENT SEALED Adjustment Device Sealed With Colored Lacquer | |
| 6.0 | CERTIFICATION I certify that the above information is correct and that the instrument installation con manufacturer and Contract Specifications, unless otherwise noted. Technician Signature Date: | forms to |
| 7.0 | ENGINEER REVIEW Calibration Witnessed: | |

Device Settings Certificate For Motor Protection Relay (MPR)

1.0 TECHNICIAN INFORMATION

Company Name: ______Address: ______

Contact Person: _____ Phone No.: _____

2.0 EQUIPMENT IDENTIFICATION

Starter or Panel Designation: _____

3.0 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 | |
| Device IDManufacturerModel No.Full Load Amp RatingLocked Rotor Current in % of FLAMaximum Allowable Stall Time in SecondsUltimate Trip Current in % of FLAPhase CT RatioGround CT Ratio50 or 60 Hertz Line Frequency Reversing or Non-reversing Starter RTD Temp in Degrees F or Degrees CWinding Temperature TripWinding Temperature TripMotor Bearing Temperature AlarmMotor Bearing Temperature Alarm | Underload Trip and Alarm Start | |
| Device IDManufacturerModel No.Full Load Amp RatingLocked Rotor Current in % of FLAMaximum Allowable Stall Time in SecondsUltimate Trip Current in % of FLAPhase CT RatioGround CT Ratio50 or 60 Hertz Line Frequency Reversing or Non-reversing Starter RTD Temp in Degrees F or Degrees CWinding Temperature TripWinding Temperature Alarm Motor Bearing Temperature Trip | Delay in Seconds | |
| Full Load Amp Dating | Underload Trip Run Delay in | |
| Fun Load Amp Rating | Seconds | |
| Locked Rotor Current in % of FLA | Phase Unbalance Trip Level | |
| Maximum Allowable Stall Time in | Phase Unbalance Trip and Alarm | |
| Seconds | Start Delay in Seconds | |
| Illtimate Trip Current in 04 of ELA | Phase Unbalance Trip Run Delay in | |
| Offinate Trip Current III % OFFLA | Seconds | |
| Phase CT Patio | Ground Fault Alarm Level in % of | |
| Fliase CT Katio | Ground CT Ratio | |
| Cround CT Patio | I ² T Alarm Level in % of Full I ² T Trip | |
| | Capacity | |
| 50 or 60 Hertz Line Frequency | Jam Alarm Level in % of FLA | |
| Reversing or Non-reversing Starter | Jam Alarm Run Delay in Seconds | |
| RTD Temp in Degrees F or Degrees C | Underload Alarm Level in % of FLA | |
| Winding Tomporaturo Trip | Underload Alarm Run Delay in | |
| | Seconds | |
| Winding Temperature Alarm | Phase Unbalance Alarm Level | |
| Motor Boaring Tomporaturo Trip | Phase Unbalance Alarm Run Delay | |
| | in Seconds | |
| Motor Bearing Temperature Alarm | Starts Per Time Allowed | |
| Load Boaring Tomporature Trip | Time Allowed for Starts Count in | |
| | Minutes | |
| Load Bearing Temperature Alarm | Time Between Starts in Minutes | |
| Auxiliary Trip | Number of Cold Starts Allowed | |
| Auxiliary Alarm | Motor Start Transition Current Level | |
| Auxiliary Alarini | in % of FLA | |
| Alarm on PTD Failura Diagnostic | Motor Start Transition Time in | |
| | Seconds | |
| Ground Fault Trip Level in % of | Transition on Time, Current, Time | |
| Ground CT Ratio | or Current, or Time and Current | |
| Ground Fault Start Delay in Cycles | Incomplete Sequence Report Back | |
| | Time in Seconds | |
| Ground Fault Run Delay in Cycles | Incomplete Seq. Start Timer | |
| Ground rault Run Delay in Cycles | Initiated by | |

| MPR SETTINGS continued | | | | | | | |
|--|--|--|--|--|--|--|--|
| Instantaneous Overcurrent in % of FLA | Long Acceleration Time in Seconds | | | | | | |
| Instantaneous Overcurrent Start Delay in Cycles | Zero Speed Switch ON or OFF | | | | | | |
| Jam Trip Level in % of FLA | Anti-Backspin Delay Time in Minutes | | | | | | |
| Jam Trip and Alarm Start Delay in Seconds | | | | | | | |

4.0 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: _____

5.0 ENGINEER REVIEW

| Calibration Witnessed: | 🗆 Yes | □ No | |
|------------------------|-------|------|--|
| Reviewer Signature | | | |

_____ Date: _____

Device Settings Certificate for Circuit Breakers

1.0 TECHNICIAN INFORMATION

Company Name: _____ Address: _____

Contact Person: ______ Phone No.: ______

2.0 EQUIPMENT IDENTIFICATION

Panel or Switchgear Designation: _____

3.0 DEVICE SETTINGS

Attach Manufacturer's form(s), with settings filled in, whenever available.

| | BREAKER SETTINGS | | | | | | | | |
|------------------|------------------|--|--|--|--|--|--|--|--|
| Breaker ID: | | | | | | | | | |
| Device | | | | | | | | | |
| Manufacturer | | | | | | | | | |
| Device Model No. | | | | | | | | | |
| Bus Number | | | | | | | | | |
| Curve Shape | | | | | | | | | |
| Inv. TM. PU. | | | | | | | | | |
| Inv. TM. MULT. | | | | | | | | | |
| Short TM. Delay | | | | | | | | | |
| Inst. PU. | | | | | | | | | |
| Discrim. | | | | | | | | | |
| High Load TM. | | | | | | | | | |
| Frequency | | | | | | | | | |
| C.T. Ratio | | | | | | | | | |
| Ground Settings | | | | | | | | | |

4.0 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: _____

5.0 ENGINEER REVIEW

Calibration Witnessed:
Yes No
Reviewer Signature Date:

Device Settings Certificate For Variable Frequency Controller

1.0 **TECHNICIAN INFORMATION**

Company Name: ______Address: ______

Contact Person: ______ Phone No.: ______

2.0 EQUIPMENT IDENTIFICATION

VFD Designation: _____

3.0 **DEVICE SETTINGS**

Attach Manufacturer's form(s), with settings filled in, whenever available.

| SETTINGS | | | | | | | |
|---|-------|-------|-------|-------|-------|--|--|
| Device ID: | VFD # | | |
| Manufacturer | | | | | | | |
| Model No. | | | | | | | |
| Accel Time (seconds) | | | | | | | |
| Decel Time (seconds) | | | | | | | |
| Minimum Speed (Hz) | | | | | | | |
| Maximum Speed (Hz) | | | | | | | |
| Current Limit (%) | | | | | | | |
| Manual Torque Boost (%) | | | | | | | |
| V/Hz Base Speed (Hz) | | | | | | | |
| RPM at Base Speed | | | | | | | |
| Output Relay Configured to | | | | | | | |
| Carrier Frequency (kHZ) | | | | | | | |
| Remote Reference Gain (%) | | | | | | | |
| Remote Reference Offset (%) | | | | | | | |
| Electronic Thermal Overload (%) | | | | | | | |
| Electronic Thermal Overload Trip (on/off) | | | | | | | |
| Coast Stop Feature (on/off) | | | | | | | |
| Reverse (on/off) | | | | | | | |
| RPM Setpoint Feature (on/off) | | | | | | | |
| Power-Up Start Feature (on/off) | | | | | | | |
| Password Lockout Feature (on/off) | | | | | | | |
| Avoidance Frequency (Hz) | | | | | | | |
| Avoidance Bandwidth (Hz) | | | | | | | |
| Multi-Speed Preset 1 (Hz) | | | | | | | |
| Multi-Speed Preset 2 (Hz) | | | | | | | |
| Multi-Speed Preset 3 (Hz) | | | | | | | |
| Auto-Restart Number of Attempts | | | | | | | |
| Auto-Restart Retry Wait Time (seconds) | | | | | | | |
| Analog Output Configured to | | | | | | | |

CERTIFICATION 4.0

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 5.0

Calibration Witnessed: 🗆 Yes 🗆 No Reviewer Signature _____ Date: _____

Section 26 0710 Demonstration and Training

Part 1 General

1.01 Section Includes

- A. Requirements for demonstration of equipment and/or systems for OWNER's personnel.
- B. Requirements for training of OWNER's personnel in the operation and maintenance of the equipment/system.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 01 7700: Closeout Procedures
- C. Section 01 7900: Demonstration and Training
- D. Section 26 0500: Common Work Results for Electrical
- E. Section 26 0510: Basic Electrical Materials and Methods
- F. Section 26 0705: Electrical Testing and Equipment
- G. Section 26 0800: Commissioning of Electrical Systems

1.03 References

- A. Equipment and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code (NEC), latest approved edition.
 - 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.

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 required under Section 01 7900, Demonstration and Training, 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 Section 26 0705, 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 0710, Demonstration and Training.

- 3. CONTRACTOR shall submit for approval a proposed agenda for said demonstration/training and shall adhere to the approved agenda for the demonstration and training session(s).
- 4. Test equipment, maintenance equipment, tools, or devices, and/or spare parts required to be furnished under Division 26 shall be turned over, and stored as required under Sections 01 6000, Product Requirements, and Section 26 0510, Basic Electrical Materials and Methods.
- 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 7700, Closeout Procedures.

3.04 Acceptance

- A. Acceptance shall occur after the above requirements have been satisfied, and as per Section 01 7700, 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 7700, 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 0800 Calibration and Start-Up of Systems

Part 1 General

1.01 Section Includes

- A. Requirements for setup and calibration of devices and instruments.
- B. Requirements for start-up of systems furnished/installed under this Contract.
- C. Calibration equipment requirements.
- D. Sample Forms.

1.02 Related Sections

- A. Section 01 4500: Quality Control
- B. Section 26 0500: Common Work Results for Electrical
- C. Section 26 0510: Basic Electrical Materials and Methods
- D. Section 26 0705: Electrical Testing and Equipment

1.03 References

- A. setup, calibration, and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Federal, State, and/or local codes, ordinances, or regulations.
- B. Equipment shall be designed, constructed, installed, tested and calibrated in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, UL, and OSHA.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, 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.

1.05 Project Record Documents

A. Submit calibration, setup and programming documentation under provisions of Section 01 7700, Closeout Procedures.

1.06 Operation and Maintenance Data

- A. Submit under provisions of Section 01 7700, Closeout Procedures.
- B. Operation Data: Include bound copies of operating and programming instructions. Include component parts replacement, adjustments, and preventative maintenance procedures and materials.
- C. 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).

1.07 Qualifications

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.

1.08 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.

1.09 Delivery, Storage and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000, Product Requirements.
- B. Accept products on site in factory containers. Inspect for damage.
- C. Turn products over to OWNER immediately.

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 0705, 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 Section 26 0705, 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 0710, 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 0710, Demonstration and Training.

3.02 Contractor's Assistance

- A. Setup, calibration, and start-up of equipment as described in Section 26 0705, 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 manufacturer's service representatives on any and all 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 0900 Instrumentation and Control for Electrical Systems – General

Part 1 General

1.01 Section Includes

A. General requirements for electrical power, instrumentation, and controls systems.

1.02 Related Sections

- A. Section 00 7200: General Conditions
- B. Section 00 7300 Supplementary Conditions
- C. Section 26 0500: Common Work Results for Electrical

1.03 References

- A. Equipment and workmanship shall be in conformance with the following documents:
 - 1. National Electrical Code, latest approved edition.
 - 2. Federal, State, and/or local codes, ordinances, or regulations.
 - 3. Latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories.
- B. Equipment shall be designed, constructed, installed, and tested in conformity with all requirements, as a minimum, of applicable standards of IEEE, NEMA, ISA, ANSI, ICEA, 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 Inspection

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 7700, Contract Closeout, 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, 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 his 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 0705, 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. Drawings shall be submitted in accordance with Sections 01 3300, Submittal Procedures and Section 01 7700, 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.
- B. Contract Drawings show the arrangement, general design, and extent of the systems.
- C. The Work is shown on the Drawings by symbols, as shown in a legend on the Drawings.

- D. 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.
- 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 7700, 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 9000, Painting and Coating.

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 0705, 26 0710, and 26 0800. See Section 01 7700, Closeout Procedures for additional requirements.

End of Section

Section 26 0913.13 Actuators and Operators

Part 1 General

1.01 Scope of Work

- A. This section includes electric motor operated actuators for 90 degrees and multiturn/rising stem applications. Actuators shall be used for open/shut and modulating/throttling service.
- B. The actuators specified herein shall be provided by the manufacturer of the gates specified in Section 40 0560.

1.02 Related Work Specified Elsewhere

- A. Division 26: Electrical
- B. Division 40: Process Interconnections

1.03 Quality Assurance

- A. Actuators specified under this section shall be furnished by one manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment furnished.
- B. Actuators and all related equipment shall be designed, constructed, and installed with the best practices and methods.

1.04 Submittals

- A. General:
 - 1. Submit to ENGINEER, in accordance with the requirements of Section 01 3300, Submittal Procedures, complete shop drawings and schematics which shall show details of installations and connections to work of other sections.
 - 2. Furnish catalogue data and parts schedule in sufficient detail to serve as a guide in assembly, disassembly of the actuator and in ordering repair parts.
- B. Certificates: The manufacturer shall provide an affidavit of compliance with applicable provisions of this Section.
- C. Operation and Maintenance Data: Submit operating instructions, repair parts listing and recommended maintenance schedule of inspection, cleaning and lubrication.
 - 1. Include manufacturers recommended lubricants.
- D. Shop Drawings and Product Data: Submit manufacturer's drawings showing the principal dimensions and general construction of and materials used in all parts of the actuator. Actuators shall be manufactured and furnished in accordance with these drawings and specifications.
 - 1. Furnish illustrated catalog data and parts schedule in sufficient detail to serve as a guide in assembly and disassembly of the valve actuator and in ordering repair parts.

- E. Test Reports: Submit copies of tests and inspection data to ENGINEER for review and record in accordance with the requirements of these Contract Documents.
- F. Actuator: Actuator shall be submitted with the equipment it will operate and will not be accepted as a stand alone submittal. Actuator sizing and selection shall be as recommended by the gate or valve supplier. CONTRACTOR shall coordinate with the valve or gate supplier to obtain operators of the proper size and type.

1.05 Product Delivery, Storage, and Handling

- A. Storage of Materials and Equipment:
 - 1. CONTRACTOR shall store material and each piece of equipment in accordance with the manufacturer's recommendation for protection from weather, temperature, and moisture contamination.
- B. Handling Materials and Equipment:
 - 1. Material shall be handled in a manner such as to eliminate the possibility of damage, breakage, or chipping in transit or otherwise.

1.06 Startup

A. Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

1.07 Performance Test Certificate

- A. Each actuator must be performance tested and individual test certificates shall be furnished to OWNER. The test equipment should simulate a typical valve load and the following parameters should be recorded:
 - 1. Current at maximum torque setting
 - 2. Torque at maximum torque setting
 - 3. Flash Test Voltage
 - 4. Actuator Output Speed or Operating Time
- B. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

1.08 Warranty

A. Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment.

1.09 Experience

A. Technologies and devices used in the actuator must have a minimum of five years of commercial operating experience for that specific manufacturer, including torque and position sensing, lubrication, and electrical compartment design.

Part 2 Products

2.01 General

- A. Actuators shall operate on a 480 volt, three-phase, 60 Hertz power supply and are to incorporate motor, solid state integral reversing starter, local control facilities, and terminals for remote control and indication connections.
- B. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without the necessity to remove any electrical compartment covers.

2.02 Actuator Sizing

- A. Actuator shall be sized to guarantee valve closure at the specified differential pressure.
- B. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.
- C. Operating speed shall be such as to give valve closing and opening at approximately 60 seconds, unless otherwise stated in the job specification.
- D. Actuator shall be capable of functioning in an ambient temperature ranging from -22 degrees to +158 degrees Fahrenheit.

2.03 Motor

- A. The electric motor shall be Class F insulated with a time rating of at least 15 minutes at 104 Fahrenheit (40 degrees Celsius) or twice the valve stroking time, whichever is the longer, at an average load of at least 33% of maximum valve torque.
- B. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case. Plugs and sockets are not acceptable as a means of electrical connection for the motor.

2.04 Motor Protection

- A. Protection shall be provided for the motor as follows:
 - 1. Motor shall be de-energized in the event of stall when attempting to unseat a jammed valve.
 - 2. Motor temperature shall be sensed by a thermostat to protect against overheating.

2.05 Gearing

- A. Actuator gearing shall be totally enclosed in an oil-filled gear case suitable for operation at any angle. Where the actuator operates gate valves or large diameter ball or plug valves, the drive shall incorporate a lost-motion hammer blow feature.
- B. For rising spindle valves, the output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the actuator, and the design should be such as to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

C. Standard SAE80EP or Dextron II gear oil shall be used to lubricate the gear case. Special or exotic lubricants shall not be used.

2.06 Hand Operation

- A. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor.
- B. Hand/Auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.
- C. Handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time.
- D. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in the job specification.

2.07 Drive Bushing

- A. Actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft.
- B. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.

2.08 Torque and Turns Limitations

- A. Torque and turns limitation to be adjustable.
- B. Torque setting: 40% to 100% rated torque.
- C. Torque sensing must be affected directly electrically or electronically. Extrapolating torque from mechanically measured motor speed is not acceptable due to response time.
- D. Torque measurement shall be independent of variations in frequency, voltage or temperature.
- E. "Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.
- F. The electric circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.
- G. A setting tool is required for non-intrusive calibration and interrogation of the actuator.
 - 1. Setting tool will provide quick interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing.
2.09 Remote Valve/Actuator Control, Status and Alarm Indication

- A. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact externally selectable as normally open or normally closed.
 - 1. Contacts shall be rated at 5A, 250V AC, 30V DC.
- B. As an alternative to providing valve position, any of the four contacts shall be selectable to signal one of the following:
 - 1. Valve Opening or Closing
 - 2. Valve Moving (Continuous or Pulsing)
 - 3. Local Stop Selected
 - 4. Local Selected
 - 5. Remote Selected
 - 6. Open or Close Interlock Active
 - 7. ESD Active
 - 8. Motor Tripped on Torque in Mid-Travel
 - 9. Motor Tripped on Torque Going Open
 - 10. Motor Tripped on Torque Going Closed
 - 11. Pre-Set Torque Exceeded
 - 12. Valve Jammed
 - 13. Actuator Being Operated by Handwheel
 - 14. Lost Main Power Phase
 - 15. Customer 24V DC or 120V AC Supply Lost
 - 16. Battery Low
 - 17. Internal Failure Detected
 - 18. Thermostat Tripped
- C. In the event of a (main) power (supply) loss or failure, the four position contacts must be self latching to maintain interlock capabilities.
- D. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2.0 kV.
- E. Operators for valves or gates listed in the valve or gate schedule as throttling service shall have 4-20 mA analog signal setpoint control module.

2.10 Local Valve/Actuator Control, Status and Alarm Indication

- A. The following Control, Status and Alarm indication shall be available locally at the actuator:
 - 1. Control:
 - a. Open/Stop/Close
 - b. Desired Valve Position Control
 - c. Positioning Units shall have a 4-20 mA input setpoint control module.
 - 2. Status:
 - a. Motor Running Open Direction
 - b. Motor Running Closed Direction
 - c. Fully Open
 - d. Fully Closed

- e. Percentage Open
- f. Percentage Torque
- 3. Alarms:
 - a. Communications Failure
 - b. Actuator Alarm
 - c. Valve Alarm
 - d. Battery Low Alarm
- B. Actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments so as to provide easy viewing regardless of mounting position.
- C. Actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments with $\pm 1/2$ percent accuracy. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.
- D. Local display should be large enough to be viewed from a distance of six feet (6') when the actuator is powered up.

2.11 Integral Starter and Transformer

- A. Reversing starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation buildup.
 - 1. For Open-Shut service, the starter shall be an electromechanical type suitable for 60 starts per hour and of rating appropriate to motor size.
 - 2. For positioning or throttling service, the starter shall be solid state suitable for excess of 2000 starts per hour.
- B. The controls supply transformer shall be fed from two of the incoming supply voltage and shall have the necessary tapings and be adequately rated to provide power for the following functions:
 - 1. 120V AC energization of the contactor coils
 - 2. 24V DC output where required for remote controls
 - 3. Supply for all the internal electrical circuits
- C. The primary and secondary windings shall be protected by easily replaceable fuses.

2.12 Integral Push Buttons and Selector

- A. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector
- B. Switch, padlockable in any one of the following three positions:
 - 1. Local Control Only
 - 2. Off (No Electrical Operation)
 - 3. Remote Control plus Local Stop Only.

- C. It shall be possible to select maintained or non-maintained local control.
- D. Selection of maintained or push-to-run control for (A) above shall be provided. It shall be possible to reverse valve travel without the necessity of stopping the actuator. Starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 ms.

2.13 Wiring and Terminals

- A. Internal wiring shall be of tropical grade PVC insulated stranded cable of appropriate size for the control and three- phase power. Each wire shall be clearly identified at each end.
- B. Terminals shall be embedded in a terminal block of high tracking resistance compound.
- C. Terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.
- D. Terminal compartment of the actuator shall be provided with a minimum of three threaded cable entries. When required, a fourth cable entry shall be provided.
- E. Wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.
- F. Control logic circuit boards and relay boards must be mounted on plastic mounts to comply with double insulated standards. No more than a single primary size fuse shall be provided to minimize the need to remove single covers for replacement.
- G. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
 - 1. Serial Number
 - 2. External Voltage Values
 - 3. Wiring Diagram Number
 - 4. Terminal Layout
- H. This must be suitable for CONTRACTOR to inscribe cable core identification beside terminal numbers.

2.14 Enclosure

- A. Actuators shall be "0" ring sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof "0" ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.
- B. Enclosure must allow for temporary site storage without the need for electrical supply connection.
- C. External fasteners should be of stainless steel.

2.15 Acceptable Manufacturers

A. Rotork Controls

Part 3 Execution

3.01 Contractor's Verification

A. CONTRACTOR shall field measure all dimensions and check possible interferences for the valve actuator system and accessories.

3.02 Preparation

- A. Valve actuators and accessories shall be free of all foreign matter.
- B. Accumulations of dirt, rust, scale, etc., shall be removed prior to installation.
- C. Connections and terminals shall be checked to ensure integrity.

3.03 Installation

- A. Install all items in accordance with printed instructions of manufacturers, as indicated and specified. Make adjustments necessary to place equipment in satisfactory working order.
- B. Valve actuators shall be aligned and supported in such manner that no load or thrust will be exerted upon the equipment or the piping at installation or in operating conditions.
- C. Joint connections shall be as indicated on the Plans and specified herein. Excluding connections for valves, fittings, equipment, etc., joints in the pipeline shall be minimal yet provide easy access as required for maintenance.

3.04 Acceptance Test

- A. Complete installation.
- B. Furnish labor, equipment, and materials necessary to conduct tests.
- C. Give each actuator a running test fully opening and closing the valve or gate in the presence of ENGINEER to demonstrate satisfactory operation.
- D. Correct all defects and replace any defective equipment. Make necessary adjustments at no additional cost to OWNER.
- E. Repeat tests if necessary at no additional cost to OWNER to obtain results acceptable to ENGINEER.

3.05 Field Quality Control

- A. Installed actuators shall be tested over their whole range of service and operating conditions.
- B. Valve and actuator shall function as an integral whole in modulating service as intended, and shall operate without "hunting", widely fluctuating or excessive cycling.

C. Testing shall be made with the temperatures of surrounding air and test water approximately constant within operating temperature ranges.

End of Section

Section 26 2419 Motor Control Centers

Part 1 General

1.01 Section Includes

A. Modifications to existing motor control centers.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0553: Identification for Electrical Systems
- D. Section 26 2416.13: Panel Components and Devices
- E. Section 26 0705: Electrical Testing and Equipment
- F. Section 26 0800: Commissioning of Electrical Systems
- G. Section 26 0710: Demonstration and Training for Electrical Systems
- H. Section 26 2813: Fuses

1.03 References

- A. NFPA 70 National Electrical Code.
- B. UL 198C High-Interrupting Capacity Fuses; Current Limiting Type.
- C. UL 198E Class R Fuses.
- D. NECA 402-2014 Motor Control Centers (ANSI).
- E. NEMA AB 1 Molded Case Circuit Breakers.
- F. NEMA ICS 2 Industrial Control Devices, Controllers, and Assemblies.
- G. NEMA ICS 2.3 Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. 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.
- C. Wiring diagrams shall be provided as specified under Section 26 0710, Demonstration and Training.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. 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.

F. 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 specified in Section 26 0500.

1.05 Operation and Maintenance Data

- A. Submit under provisions of Section 017700.
- B. 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 Assurance

A. Perform Work in accordance with NEMA ICS 2.3.

1.07 Regulatory Requirements

- A. Conform to requirements of NFPA 70.
- 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.

1.08 Delivery, Storage, and Handling

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 6000.
- 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.

1.09 Environmental Requirements

A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.10 Field Measurements

A. Verify that field measurements are as indicated on the Drawings.

1.11 Extra Materials

- A. Furnish under provisions of Section 01 6000, 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 0710, 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 inches high by 3-1/2 inches wide (minimum), white laminated plastic with engraved black letters. Letters shall be 1/8-inch 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. Equipment devices mounted within the units shall be identified as to function and schematic identification abbreviation. Identification plates shall be 1-inch by 3 inches engraved white lamicoid 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 0705, Electrical Testing and Equipment.
- H. Added control devices shall be as specified in Section 26 0900, 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 internal components and wiring terminal strip connections, 480 volt power wiring, 120 volt control and power wiring, instrument wiring , and 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 degrees Celsius 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 degrees Celsius. 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.
- 0. 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 6000, 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 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 0553, 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 0553, Electrical Identification.

3.03 Field Quality Control

- A. Field inspection and testing shall be performed under provisions of Sections 01 4500, Quality Control, and Section 26 0705, Electrical Testing and Equipment.
- B. Inspect and test each added or modified controller to NEMA ICS 2.

End of Section

Section 26 2726 Wiring Devices

Part 1 General

1.01 Section Includes

- A. Wall switches.
- B. Receptacles.
- C. Device plates and box covers.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0533.16: Boxes for Electrical Systems

1.03 References

- A. NECA Standard of Installation.
- B. NEMA WD 1 General Requirements for Wiring Devices.
- C. NEMA WD 6 Wiring Device Dimensional Requirements.
- D. NFPA 70 National Electrical Code.

1.04 Submittals for Review

- A. Submit under provisions of Section 01 3300, Submittal Procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, finishes, and configurations.
- C. Submit manufacturer's installation instructions.

1.05 Regulatory Requirements

- A. Conform to requirements of NFPA 70.
- B. 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.

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 standard 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 existing conditions prior to beginning work.
- 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 Preparation

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.03 Installation

- A. Install in accordance with NECA "Standard of Installation."
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on 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 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 0553, Electrical Identification, for nameplate, circuit number marker, wire marker, etc. requirements.

3.04 Interface with Other Products

A. Coordinate locations of outlet boxes provided under Section 26 0533.16, Boxes for Electrical Systems, to obtain mounting heights specified or indicated on the Drawings.

3.05 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.

3.06 Adjusting

A. Adjust devices and wall plates to be flush and level.

3.07 Cleaning

- A. Refer to Section 01 7700, Closeout Procedures, with regard to cleaning installed work.
- B. Clean exposed surfaces to remove splatters and restore finish.

End of Section

Division 31 Earthwork

Section 31 2200 Grading

Part 1 General

1.01 Scope of Work

A. This Section includes site grading as indicated on the Plans, complete with removing and salvaging topsoil, rough grading, finish grading, adjusting structures, and reconstructing structures.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2313: Subgrade Preparation
- D. Section 31 2316: Structural Excavation and Backfill
- E. Section 32 9219: Seeding

1.03 Soil Erosion and Sedimentation Control

- A. CONTRACTOR, at his expense, 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 ENGINEER.
- B. 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.
- C. Measures should include provisions to reduce erosion by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products (Not Used)

Part 3 Execution

3.01 Site Grading

- A. Sites shall be graded as specified on the Plans or as determined by ENGINEER. CONTRACTOR shall carry out the grading operation to prevent standing water and soil saturation detrimental to structures and improvements.
- B. Provisions shall be made to preserve and protect trees and other vegetation specified on the Plans or determined by ENGINEER as not to be removed.

3.02 Removing and Salvaging Topsoil

- A. Topsoil encountered along the route of the construction shall be pushed back and preserved for use in restoration following completion of the construction.
- B. Topsoil must remain on each given parcel and lot throughout the Project including the existing road right-of-way adjoining the parcel or lot where it existed.

- C. Removal of topsoil from the Project or movement of topsoil from one portion of the Project for use in another portion of the Project will not be allowed.
- D. If there is insufficient working area, the topsoil may be removed, stockpiled and later replaced on the original lot or parcel. CONTRACTOR shall furnish ENGINEER with written permission obtained from the property owner of the property on which the topsoil is to be stockpiled, prior to commencing the stockpiling operation.
- E. Topsoil shall be salvaged in an amount equivalent to the quantity required by the Plans. Topsoil salvaged in excess of that required by the Plans or as required by ENGINEER will be disposed of by CONTRACTOR at his expense.
- F. Before removing topsoil, all vegetation shall be reduced to a height of approximately four inches (100 mm) and all such vegetation and all brush, stones, rocks, and any other objectionable litter or foreign material shall be removed and disposed of before the ground is broken for topsoil removal.
- G. Equipment and methods of operations shall be such as to avoid the lifting of the subsoil. If soil or weather conditions are unsuitable, CONTRACTOR shall cease stripping until stripping can resumed in a suitable manner.
- H. Topsoil shall be removed within the grading limits for cuts and shall be removed to a width and depth specified on the Plans or as determined by ENGINEER.
- I. Topsoil shall be stockpiled within the limits of construction in areas designated on the Plans, or in areas out of the way of construction as determined by CONTRACTOR. Stockpiles shall be located and shaped so as to avoid diversion of storm water runoff, either in or out of the limits of construction, towards buildings, creation of standing water or interference of controlled irrigation. CONTRACTOR shall not place topsoil around trunks and root areas of trees to be preserved.
- J. Topsoil shall be kept separate from other excavated materials that are to be used for embankment and shall be completely removed from any designated area prior to the beginning of regular excavation or placing embankment in the area.
- K. Topsoil stockpiles shall be located as near the original location as possible and no payment will be made for overhaul.
- L. After the completion of construction, the topsoil shall be screened through a 5/8-inch maximum size mesh screen, spread, graded, raked and prepared for seeding or sodding.

3.03 Existing Sand Onsite

- A. In those instances where the construction takes place within private easements, the sand shall not be removed from each parcel or lot. Sand encountered in existing road right-of-way may be used for construction purposes throughout the Project providing it meets the requirements for the material it is intended to be used for.
- B. Removal of sand from the Project will not be allowed, except for the volume displaced by the new construction.
- C. If there is insufficient working area, the sand may be removed, stockpiled and replaced on the original lot or parcel. CONTRACTOR shall furnish ENGINEER with written permission obtained from the property owner of the property on which the sand is to be stockpiled, prior to commencing the stockpiling operations.

3.04 Rough Grading

- A. Site shall be graded as necessary to comply with the Plans or as determined by ENGINEER. The subgrade shall be roughly established by cut or fill, approximately parallel to proposed finished grades and to elevations which allow for thickness of topsoil and installation of site or roadway improvements.
- B. In fill areas all debris shall be removed from the area to be filled. Material detrimental to site improvement shall be removed from the site and acceptably disposed of as specified in Section 01 8900 Site Construction Performance Requirements.
- C. Original ground shall be scarified and benched or otherwise treated to provide adequate bond and to prevent slippage of fill.
- D. Fill material shall be free of debris or other detrimental material and shall have a moisture content within 2 percent of optimum moisture when placed. All fill shall be compacted to a density not less than 95% of the maximum unit weight and placed in layers no less than nine inches (230 mm) and no greater than 15 inches (380 mm). The maximum unit weight shall be determined by ASTM D698, Method B.
- E. If possible fills or embankments shall be constructed when the ground is frost-free and there is favorable weather. However if winter grading is necessary, all ice and snow shall be removed from the surface of the ground before the fill or embankment is placed. No frozen material will be allowed in the fill area or in the embankment being constructed. Any frozen material on a partially completed fill shall be removed before placing any more fill. Frozen material shall be stockpiled outside the grading limits until thawed. Thawed material from the stockpiled frozen material may be used in the fill and embankment areas.

3.05 Finish Grading

- A. General:
 - 1. Subgrade shall be smoothed parallel to proposed finished grades and elevations specified on the Plans. The subgrade shall be scarified to assure bond with the topsoil prior to spreading of the topsoil.
 - 2. Topsoil shall be spread uniformly to provide a smooth, even surface at a finish grade specified on the Plans or acceptable to ENGINEER. After spreading, the topsoil shall be compacted lightly as necessary to minimize settlement. Final grades shall not vary more than one-tenth of a foot (30 mm) from the elevations indicated on the Plans.
 - 3. Finished grading shall be done when the ground is frost-free and weather is favorable.
- B. Adjust Structures:
 - 1. Structures to be adjusted shall be as called for on the Plans or as indicated by ENGINEER.
 - 2. Adjustment of structures shall apply where the elevation of the casting is either raised 12 inches (300 mm) or less, or lowered six (6) inches (150 mm) or less.
- C. For Rehabilitation/Resurfacing Projects:

- 1. For structures in existing pavement, the pavement shall be sawcut a minimum of 5foot by 5-foot unless otherwise shown on the plans.
- 2. For structures in concrete pavement, the structure shall be adjusted, backfilled and compacted as noted below.
- 3. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.
- 4. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.
- 5. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans.
- 6. Concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.
- 7. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed.
- 8. Structure shall be adjusted, backfilled and compacted as noted below.
- 9. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
- 10. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses.
- 11. The bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.
- D. For Bituminous Reconstruction or New Construction Projects:
 - 1. Frame and cover on all new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses.
 - 2. Bituminous base and leveling courses shall be placed over the plated structures.
 - 3. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
 - 4. Structure shall be adjusted, backfilled and compacted as noted below.
 - 5. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
 - 6. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course.
 - 7. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.

- 8. Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the adjusting the structure unless otherwise noted in the Contract Documents.
- 9. Existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure, unless a new frame and cover are called for on the Plans.
- 10. Brick courses or concrete adjustment rings shall be removed or installed as necessary to adjust the structure's frame and cover to the proper elevation.
- 11. Brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by ENGINEER.
- 12. Outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 inch (10 mm) thick.
- 13. Structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of ENGINEER.
- 14. Flow in the entire system shall be maintained, at CONTRACTOR's expense, while performing any part of the Work. Also, the structure shall be cleaned and all unsuitable material shall be disposed of at CONTRACTOR's expense.

3.06 Reconstruct Structures

- A. General:
 - 1. Structures to be reconstructed shall be as called for on the Plans or as determined by ENGINEER.
 - 2. Reconstruction of structures shall apply where the elevation of the casting must be raised in excess of 12 inches (300 mm), lowered in excess of six (6) inches (150 mm), or to rebuild portions of the existing structure which are deteriorated.
- B. For Rehabilitation/Resurfacing Projects:
 - 1. For structures in existing pavement, the pavement shall be sawcut a minimum of 5foot by 5-foot unless otherwise shown on the plans.
 - 2. For structures in concrete pavement, the structure shall be reconstructed, backfilled and compacted as noted below.
 - 3. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed concrete pavement.
 - 4. In areas of new concrete pavement, the concrete pavement around the structure shall be poured integral with the rest of the pavement.
 - 5. For resurfacing projects, expansion or epoxy anchored hook bolts shall be placed 18-inches on center around the edges of the existing concrete pavement, unless otherwise shown on the plans.
 - 6. Concrete pavement, minimum 8-inches thick, shall be replaced around the structure to the grade of the adjoining concrete pavement.

- 7. For structures in bituminous pavement, the pavement shall not be sawcut until after the bituminous base or leveling courses have been completed.
- 8. Structure shall be reconstructed, backfilled and compacted as noted below.
- 9. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
- 10. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base or leveling courses.
- 11. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.
- C. For Bituminous Reconstruction or New Construction Projects:
 - 1. Frame and cover on new and existing structures shall be removed and the structure plated prior to placing the bituminous base or leveling courses.
 - 2. Bituminous base and leveling courses shall be placed over the plated structures.
 - 3. Prior to placing the bituminous wearing course, the bituminous base and leveling courses shall be sawcut a minimum of 5-foot by 5-foot unless otherwise shown on the plans.
 - 4. Structure shall be reconstructed, backfilled and compacted as noted below. Six inches of aggregate base course, unless otherwise noted on the plans, shall be placed below the proposed pavement.
 - 5. A minimum of 8-inches of concrete pavement, unless otherwise noted on the plans, shall be placed to the elevation of the adjoining bituminous base course.
 - 6. Bituminous wearing course around the structure shall be placed integral with the wearing course on the remainder of the project.
 - 7. Sawcutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the reconstructing the structure unless otherwise noted in the Contract Documents.
 - 8. Existing frame and cover shall be carefully removed and stored, and shall be reinstalled on the same structure unless a new frame and cover are called for on the Plans.
 - 9. Existing corbel entrance sections or precast concrete chimney type entrance shall be removed along with any additional brick courses or precast concrete sections necessary to achieve the amount of reconstruction called for on the Plans or as determined by ENGINEER.
 - 10. The necessary brick work and precast concrete sections shall be installed to meet the design grade.
 - 11. Manhole steps shall be furnished and shall be installed, as necessary, so that maximum spacing is 24-inches (600 mm).

- 12. Brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by ENGINEER.
- 13. Outside surface of the new brick or block structures shall receive a masonry plaster coat, a minimum of 1/2 (10 mm) inch thick.
- 14. Structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of ENGINEER.
- 15. Flow in the entire system shall be maintained, at CONTRACTOR's expense, while performing any part of the Work.
- 16. Structure shall be cleaned and all unsuitable material shall be disposed of at CONTRACTOR's expense.

End of Section

Section 31 2313 Subgrade Preparation

Part 1 General

1.01 Scope of Work

A. This Section includes preparing subgrade for pavement construction complete with excavation, embankments, proof rolling, subgrade undercut and backfill, subgrade stabilization fabric, subbase, right-of-way ditching, right-of-way restoration, field quality control, and appurtenances.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2319: Dewatering
- D. Section 32 9219: Seeding

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 ASTM International
 - 2. AASHTO American Association of State Highways and Transportation Officials
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

A. Finish subgrade surface shall be shaped to conform to plan grade and cross section within a tolerance of one-inch (25 mm) in ten (10) feet (3.0 m).

1.05 Submittals

- A. Test Reports:
 - 1. Testing lab shall provide ENGINEER with two (2) certified copies of the sieve analysis of the backfill material.
 - 2. Testing of the material and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.
 - 3. Testing lab shall provide ENGINEER with two (2) certified copies of the compaction and moisture tests of the backfill and subgrade materials.
 - 4. Testing of the materials and the certification of the test results shall be performed by a testing laboratory approved by the ENGINEER.
- B. Samples:
 - 1. Submit sample of the proposed subgrade stabilization fabric measuring not less than 1 yd² (1 m²) in area, and the manufacturer's certification that the proposed fabric meets or exceeds all requirements listed in Article 2.03 of this Section.

2. Submissions shall be made not later than 10 working days prior to any installation.

1.06 Product Delivery Storage and Handling

- A. Geotextile fabric shall be furnished and stored in a wrap that will protect the geotextile from ultraviolet radiation and abrasion.
- B. Geotextile shall be covered with the aggregate base as per plan within two (2) weeks of its placement.

1.07 Soil Erosion and Sedimentation Control

- A. 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 ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the drain, to reduce erosion of the slopes, and to prevent silting in of drain downstream of the Work.
- C. Measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Granular Materials

A. Granular material gradation shall conform to the grading requirements for granular material Class II as specified in MDOT, Section 902.08.

2.02 Aggregate Materials

- A. Aggregate materials, used for undercut backfill shall be crushed limestone, natural aggregate, blast furnace slag, or crushed concrete, meeting the requirements of 21AA, 21A or 22A as specified in MDOT Section 902.06.
- B. Crushed concrete shall be free of all steel and other deleterious materials.

2.03 Subgrade Stabilization Fabric

A. Subgrade stabilization fabric shall be composed of synthetic fibers formed into a woven fabric. The fibers shall be composed of 85% propylene or ester polymers. The geotextile shall conform to the following requirements listed below:

| Property | Test Procedure | Test Result |
|-----------------------|----------------|--------------------|
| Grab Tensile | ASTM D4632 | 270 lbs. (min) |
| Elongation | ASTM D4632 | 15% (min) |
| Trapezoidal Tear | ASTM D4533 | 100 lbs. (min) |
| CBR Puncture Strength | ASTM D6241 | 900 lbs. (min) |
| Apparent Opening Size | ASTM D4751 | 40 – 70 U.S. Sieve |
| Permittivity | ASTM D4491 | 0.05 per sec (min) |

Part 3 Execution

3.01 Removing Structures

A. Structures and sewers to be removed shall be called for on the Plans or as determined by ENGINEER. Removal or abandonment of structures shall be in accordance with Section 01 8900, Site Construction Performance Requirements.

3.02 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 approved by ENGINEER.
- B. Material shall be compacted to 95% of its maximum unit weight.
- C. Furnishing, placing and compacting of the backfill material shall be at CONTRACTOR's expense.

3.03 Salvaging and Stockpiling Topsoil

- A. Topsoil, within the grading limits for cuts, and where the fill is less than five (5) feet (1.5 m) in height to the top of proposed road, shall be removed to a depth and width specified on the Plans.
- B. Topsoil from peat and muck areas shall not be removed.
- C. Topsoil salvaged in excess of that required by the Plans will be disposed of by the CONTRACTOR at his expense.
- D. Removing and salvaging topsoil shall be in accordance with Section 31 2200, Grading.

3.04 Preparing Roadway Subgrade

- A. Muck, peat and other unsuitable material within the roadway shall be removed, displaced or otherwise treated, as shown on the Plans or as directed by ENGINEER.
- B. Deposits of frost heave material within lines two (2) feet (0.6 m) outside the proposed roadbed shall be removed to a depth of three (3) feet (0.9 m) below the surface of the earth grade, unless otherwise shown on the Plans or as determined by ENGINEER.
- C. Ice and snow shall be removed from the surface of the ground before the embankment is placed.
- D. Muck, peat, frost heave material and other unsuitable material shall be disposed of outside the highway limits or shall be spread uniformly in low places beyond the roadway limits when so approved by ENGINEER.
- E. Old road surfacing or gravel, crushed stone, or other nonrigid type surfacing, occurring within the area of the roadbed and underlying proposed embankment less than 1-foot in depth, and which is not to be salvaged and incorporated in the new Work, shall be plowed or scarified full depth, spread and compacted to form a uniform foundation, before any new embankment is placed.
- F. Old pavement and other rigid structures, occurring within the area of the roadbed and underlying the proposed embankment less than 1-foot in depth and which are not to be incorporated into the new Work, shall be broken up and removed.

3.05 Subgrade

- A. Area to be paved shall be excavated and smoothed to the line, grade and cross section as indicated on the Plans.
- B. Subgrade between the lines two (2) feet (0.6 m) on either side of the proposed edge of pavement or curb shall be compacted to 95% of the maximum unit weight for a depth of seven (7) inches (175 mm), by rolling with a roller weighing not less than ten (10) tons (9000 kg).
- C. Subgrade shall be completed ahead of placing forms or paving a distance equal to the distance of one day's average paving operation. Prior to the paving operation, the subgrade shall be shaped and compacted to the Plan cross section by approved mechanical means.

3.06 Pavement Excavation

- A. Pavement excavation shall consist of all Work required to construct the earth grade and its appurtenances true to the lines, grades, and cross sections called for on the Plans and in accordance with these Specifications.
- B. Excavation shall consist of the following items, any of which or all of which may be included or incidental to it; removing trees, stumps, hedges, roots, culverts, sewers, miscellaneous structures, roadway excavation, removing of all asphalt or concrete pavements, curbs, curb and gutters, sidewalks, end headers, removing aggregate surfaces, salvaging and stockpiling topsoil, subgrade undercut, excavation for structures, trimming and finishing earth grade, fine grading, right-of-way ditching and restoration, and the disposal of all unsuitable material.
- C. Large stones, trees, stumps, brush, shrubs, logs, matted roots, other vegetation and debris occurring between lines three (3) feet (0.9 m) outside the grading limits or as otherwise shown on the Plans shall be completely removed and properly disposed of as specified in Section 31 1100, Clearing and Grubbing.
- D. Earth and other existing materials shall be excavated for the full depth and width of the cross section as shown on the Plans. Material shall be excavated sufficiently for setting of forms or slip-form equipment. Excavation shall be limited to 3,000 linear feet (900 m) of right-of-way unless additional lengths are requested in writing and approved by ENGINEER.
- E. Excess excavated material shall be removed from the project by CONTRACTOR along approved routes to disposal sites approved by OWNER. Disposal of excess excavation and maintenance of the dump sites shall be considered incidental to the price paid for excavation and shall be as specified in Section 01 8900, Site Construction Performance Requirements.

3.07 Borrow Excavation

A. Materials which are secured from locations outside of the project limits for the purpose of completing embankments and other items, will be considered as borrow excavation.

Borrow pits and the materials to be removed therefrom shall be subject to the inspection of ENGINEER and shall be secured by CONTRACTOR, unless otherwise provided.

B. Borrow excavation will be measured by volume in cubic yards compacted in place, based on the neat lines called for on the Plans or as authorized by ENGINEER. To facilitate the accurate measurement of borrow quantities, unless otherwise specified in the Contract Documents, CONTRACTOR shall perform all the regular excavation and grading with existing materials for any designated area and ENGINEER will cross section these areas prior to CONTRACTOR furnishing and placing the required borrow material. ENGINEER will then resection the completed area and compute the volume of borrow material in its compacted-in-place state. Any borrow material placed beyond the neat lines called for on the Plans or which is not authorized by ENGINEER in writing will not be measured and computed as borrow excavations. Measurement of borrow material by truck count will not be acceptable.

C. Public and private roads used by CONTRACTOR between the source of borrow and the Project shall be maintained by ONTRACTOR, at his expense, including repairs of any damage caused by his operations. Also included is the application of a dust palliative when necessary, as determined by ENGINEER.

3.08 Embankments

- A. Embankments shall be constructed with sound earth. Materials shall be deposited and compacted by either the Twelve Inch Layer Method, or the Controlled Density Method. The Controlled Density Method will be required unless the twelve inch layer method or some other method is specifically called for on the Plans.
- B. Topsoil shall be stripped from the entire fill area. Depth of the topsoil to be removed shall be as shown on the Plans or as determined by ENGINEER. After the topsoil is removed, the entire area upon which the embankment is to be constructed shall be compacted to not less than 90% of the maximum unit weight, to a depth of nine (9) inches (225 mm).
- C. Where stones are prevalent, the material shall be carefully placed so that all large stones will be well distributed and the crevices completely filled with smaller stones, earth, sand or gravel so as to form a solid embankment. Rock or fragmental material of such size as would prohibit it from being placed in layers of the specified depth shall not be placed in the embankment. In no case shall stones over three (3) inches (75 mm) in diameter be placed within 12 inches (300 mm) of the surface of the earth grade within the areas between lines two (2) feet (0.6 m) outside of the edges of proposed roadbed.
- D. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material.
- E. Construction requirements for the two (2) methods of placing and compacting embankments are as follows:
 - 1. Twelve-Inch Layer Method:
 - a. Material shall be deposited and spread in layers not more than 12 inches (300 mm) in depth, loose measure, parallel to the finished grade and extending to the full width of the embankment. Material shall be deposited by operating the conveying equipment over the layer being placed, insofar as feasible.
 - b. Each layer shall be compacted to not less than 95% of the maximum unit weight as determined at the existing moisture content. Operation of compacting shall be continued until each layer is compacted to the required density for its full width.
 - 2. Controlled Density Method:
 - a. Material for the embankment shall be deposited and spread in layers not more than nine (9) inches (225 mm) in depth, loose measure, and extending to the full width of the embankment, except that granular

material may be spread and compacted in layers not more than 15 inches (375 mm) in thickness if the specified density is obtained.

- b. Material for embankments of five (5) feet (1.5 m) or less and the bottom four (4) feet (1.2 m) of embankments of more than four (4) feet (1.2 m) above the surface of the ground upon which the embankment is to be constructed shall have not more than the optimum moisture content at the time of compaction.
- c. Material for that part of the embankment more than five (5) feet (1.5 m) above the surface of the ground upon which the embankment is to be constructed shall have a moisture content of not greater than three (3) percent above optimum at the time of compaction, except that the moisture content of the top three feet (0.9 m) of the embankment shall not exceed optimum. If granular material is used to construct the embankment, it shall be at a moisture content below saturation.
- F. If the material contains an excess of moisture, it shall be dried to the required moisture content before being compacted.
- G. Each layer of material containing the required amount of moisture shall be compacted to not less than 95% of its maximum unit weight, unless otherwise specified, before the succeeding layer is started.
- H. When the original ground upon which the embankment is being placed, or any section of compacted embankment, or the soil in cut sections becomes rutted or distorted by CONTRACTOR's equipment, the method of operation shall be changed to eliminate this condition. CONTRACTOR shall reshape and recompact any areas so rutted or distorted at his own expense. This shall be done before any succeeding layers are placed.

3.09 Rough Grading

- A. CONTRACTOR shall rough grade as close as possible to finished subgrade leaving a minimum to be removed in fine grading.
- B. Excavated material removed during grading and stored along the line of Work between curb and sidewalk on improved lawns shall not be left longer than 48 hours. Lawns or otherwise improved areas shall be left in a neat and clean state within the specified 48 hours.
- C. During the excavation operation, including the placing of the subbase, the Work area shall be kept free of water. A dewatering system shall be provided and maintained by CONTRACTOR at his expense. The dewatering system shall remain in operation until the paving is completed.

3.10 Proof Rolling

- A. After removal of topsoil or other overburden and after construction of embankments, proof roll the existing subgrade with six passes of a minimum 15 ton pneumatic-tired roller. Operate the roller in a systematic manner to assure the number of passes over all areas, and at speeds between 2.5 and 3.5 miles per hour. When proof rolling under structures, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes.
- B. Proof rolling shall be done in the presence of ENGINEER. Rutting or pumping shall indicate unsatisfactory material and that material shall be undercut as determined by ENGINEER, and replaced with the appropriate fill material.

C. Perform proof rolling only when weather conditions permit. Do not proof roll wet or saturated subgrades. Materials degraded by proof rolling a wet or saturated subgrade shall be replaced by CONTRACTOR as determined by ENGINEER at no cost to OWNER. Notify ENGINEER 3 days prior to proof rolling.

3.11 Subgrade Undercut Excavation

- A. Unsuitable subgrade excavation shall be the operation of:
 - 1. removing unsuitable soils as determined by ENGINEER, below the level of the ground after topsoil has been stripped in fill areas where the embankment is to be five (5) feet (1.5 m) or less in height to plan grade, or
 - 2. the removal of unsuitable soils below the subgrade elevation, as determined by ENGINEER in cut areas after the subgrade has been established.
- B. In fill areas, after topsoil has been stripped in accordance with Article 3.03 of this Section, ENGINEER will inspect the embankment area to certify the adequacy of the native soils and to determine the extent of any additional excavation of unsuitable soils prior to placing the first lift of the embankment.
- C. In cut areas after the subgrade elevation has been established by the mass grading operation, ENGINEER will inspect the subgrade to determine the extent of any additional excavation of unsuitable soils.
- D. The areas excavated of unsuitable material, unless otherwise specified in the Contract Documents, shall be backfilled with nonfrost heaving material similar to the adjacent soil. However, in areas as determined by ENGINEER where free water due to seepage is present, the excavation shall be backfilled with Granular Material, Class II, and drainage shall be provided. Backfill shall be compacted to not less than 95% of the maximum unit weight, unless otherwise specified.

3.12 Subgrade Stabilization Fabric

- A. Place Subgrade Stabilization Fabric on prepared subgrade or subbase in the manner and at the location as called for on the plans. Fabric shall be laid smooth and free of tension stress, wrinkles or creases.
- B. Fabric strips shall be placed to provide a minimum overlap of 24 inches (600 mm) for each joint.
- C. Fabric shall be placed so that the upper strip will overlap the next lower strip.
- D. Should the geotextile be damaged during construction, the torn or punctured section shall be repaired by placing a piece of fabric that is sufficiently large to cover the damaged area plus two feet (0.6 m) to adjacent undamaged geotextile in all directions.

3.13 Trimming and Finishing Earth Grade

- A. After the earth grade has been constructed to the required grade, all stones and rocks more than 3 inches (75 mm) in diameter, appearing on the surface of the subgrade shall be removed.
- B. Earth grade and the subgrade shall be trimmed to the grade called for on the Plans. Subgrade, where a subbase or base course is required, shall be trimmed to the established grade within \pm 0.1 foot (30 mm). Where a subbase or base course is not required, the subgrade shall be trimmed to the established grade within \pm 3/4 inch (20 mm).

- C. Earth grade outside the subgrade shall be trimmed, all irregularities made smooth and the entire site or roadway completed to the required lines, grades, and cross sections. Backslopes and fill slopes shall be finished as either Class A or Class B slopes. Class A slopes shall be required unless otherwise specified in the Contract Documents.
 - 1. Class A Slopes:
 - a. Class A slopes shall be finished to the average slopes shown on the Plans with no variations at any point more than 0.1 foot (30 mm) above or below the established grade measured at right angles to the slopes.
 - 2. Class B Slopes:
 - a. Class B backslopes shall be finished to the average slopes shown on the Plans with no variations at any point more than 0.5 foot (150 mm) above or below the established grade measured at right angles to the slope. The degree of finish of the slopes shall be that obtainable from machine operations. The smoothness of surface finish ordinarily associated with template or string line and hand operations will not be required, but abrupt variations will not be permitted. Debris except sod, leaf mold and rotted forest litter shall be removed and loose clods of earth extending beyond the 0.5 foot (150 mm) tolerance shall be broken or removed.
 - b. Class B fill slopes shall be finished to within 0.2 foot (60 mm) of the established grade and cross section from the outside shoulder line for a distance of three (3) linear feet (0.9 m) down the slope. The remainder of the completed fill slope shall conform to the requirements for Class B backslopes.
 - c. Where waste earth or other surplus material is deposited on fill slopes, the slopes may be flattened or otherwise altered as directed by ENGINEER, to produce a uniform cross section which blends with the topography and presents a pleasing appearance.
- D. Where trees or other restrictions do not interfere, the tops of backslopes, bottoms of fill slopes and all other angles in the lines of the cross section shall be rounded to form vertical curves as shown on the Plans or as determined by ENGINEER. Transitions in length of vertical curves shall be gradual and shall present a uniform and attractive appearance. When ditches are constructed in peat, vertical curves may be omitted.

3.14 Subbase

- A. Granular material for subbase shall be evenly spread and compacted as specified in MDOT Section 301.
- B. Thickness of each layer placed shall be determined by the required density obtained but shall not exceed 15 inches (375 mm) in depth, loose measure.
- C. Subbase shall be constructed to the alignment, grade and cross section shown on the Plans. Should the subgrade at any time prior to or during the placing of the subbase become soft or unstable so that rutting occurs in the subgrade, or if the subgrade material is forced up into the subbase material, the operation shall immediately cease and the mixed material shall be removed and disposed of. Subgrade shall be corrected and new subbase material placed and compacted. This Work shall be considered incidental to the construction of the Project.

3.15 Scarify, Re-Grade and Compact Existing Subgrade

A. Existing subgrade (base) shall be scarified to a depth of 9-inches to the limits as shown on the plans. Subgrade shall then be re-shaped to the cross section as shown on the plans and compacted. Subgrade shall then be compacted to 95% of the maximum unit weight by rolling with a roller weighing not less than ten (10) tons (9000 kg).

3.16 Roadway Ditching

- A. Ditching shall be constructed at the locations called for on the Plans or as determined by ENGINEER. Ditch may be shaped by "Machine Grading" or another method approved by ENGINEER to achieve the cross section, line and grade shown on the Plans.
- B. Excess material from the ditch construction shall be disposed of by CONTRACTOR at his expense.
- C. Ditch section shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place and compact any additional material needed to construct the ditch at the location and cross sections called for on the Plans.

3.17 Right-of-Way Restoration

- A. Right-of-way shall be restored in accordance with the type and location specified on the Plans. Right-of-way may be shaped by "Machine Grading" or another method approved by ENGINEER to achieve the cross section, line and grade shown on the Plans.
- B. Excess material from the right-of-way restoration operation shall be disposed of by the CONTRACTOR at his expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- C. Right-of-way shall be graded to receive either topsoil and seed or topsoil and sod. Topsoil, seed, sod, fertilizer and mulch shall conform to the requirements specified on the Plans and in Section 32 9219, Seeding or Section 32 9223, Sodding.
- D. CONTRACTOR, at his expense, shall furnish, place, and compact any additional fill, meeting the approval of ENGINEER, needed to construct the right-of-way to the cross sections called for on the Plans.

3.18 Machine Grading

- A. Work of machine grading shall consist of light grading of such character that, in general, the excavation from ditches and roadbed will be utilized in shaping shoulders and adjacent shallow fills and the work can be performed by a blade grader or similar equipment. Machine grading shall apply on the sections shown on Plans or specified in the Proposal.
- B. Work shall include all necessary scarifying, plowing, discing, moving and shaping the earth to develop the cross section shown on Plans.
- C. Ditches shall be in reasonably close conformity with the line and grade as shown on the Plans or as directed and must drain runoff waters to outlets shown on the Plans or designated by ENGINEER.
- D. Roadbed shall be finished to grade with a blade grader or equivalent equipment.

E. Intersections, approaches, entrances, and driveways shall be graded as shown or as directed, except that loading and hauling of earth will not be required as part of this Work.

3.19 Maintenance Aggregate

A. CONTRACTOR shall furnish and install 21A, 21AA or 22A maintenance aggregate to maintain pedestrian and traffic access. Aggregate shall be placed and compacted to maintain access in areas as determined by ENGINEER. Maintenance aggregate will be incidental to the Project unless otherwise specified in the Contract Documents.

3.20 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction, sieve analysis and moisture content of the backfill and subgrade materials.
- B. Taking of samples and the testing required shall be performed by a testing laboratory suitable to OWNER and approved by ENGINEER. Cost for testing and sampling shall be at the expense of OWNER.
- C. ENGINEER shall determine the location and number of samples to be made. The testing laboratory shall furnish the ENGINEER with two (2) certified copies of the results of all tests.
- D. Testing procedures shall conform to current MDOT Standards for Construction.
- E. Maximum unit weight when used as a measure of compaction or density of soils shall be understood to mean the maximum unit weight per cubic foot (or cubic meter) as determined by ASTM D1557, Method D, modified to include all the material passing the 1-inch (25 mm) sieve.

3.21 Defective Work

- A. Any portion of the backfill, subbase or subgrade which is deficient in the specified density shall be corrected by methods meeting the approval of ENGINEER.
- B. Extra testing or sampling required by ENGINEER, because of deficiencies, shall be at CONTRACTOR's expense.

End of Section
Section 31 2316 Structural Excavation and Backfill

Part 1 General

1.01 Scope of Work

A. This Section includes excavation for structures, removal and disposal of excavated materials, backfilling, backfill materials and compaction.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2200: Grading
- D. Section 31 2319: Dewatering
- E. Section 32 9219: Seeding
- F. Section 33 3400: Sanitary Utility Force Mains

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 ASTM International
 - 2. AASHTO American Association of State Highways and Transportation Officials
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Submittals

A. Testing laboratory shall provide ENGINEER with two (2) certified copies of the test results of the compaction of the backfill. The testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.05 Soil Erosion and Sedimentation Control

- A. 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 ENGINEER.
- B. 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.
- C. Measures should include provisions to reduce erosion by the wind of areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Granular Materials

A. Granular material gradation shall conform to the grading requirements for granular material, Classes I and II, as specified in MDOT, Section 902. Granular material shall be natural bank run sand.

2.02 Coarse Aggregate

A. Coarse aggregate gradation shall conform to coarse aggregate, 6A, as specified in MDOT, Section 902.

Part 3 Execution

3.01 Dewatering

- A. Area within the vicinity of the new Work shall be dewatered in accordance with Section 31 2319, Dewatering prior to the excavation operation.
- B. Depth of the dewatering shall be sufficient to allow the excavation to remain in a dry condition during the construction of the structure, including the excavating, backfilling and compacting operations.

3.02 Sheeting, Shoring, and Bracing

- A. CONTRACTOR shall furnish, place and maintain such sheeting, shoring, and bracing of the excavated area as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipelines and conduits next to, or crossing the excavated area, and for the protection and safety of pedestrian and vehicular traffic.
- B. CONTRACTOR shall be responsible for the complete design of sheeting, shoring and bracing Work.
- C. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil.
- D. Prior to installing the sheeting, shoring or bracing, CONTRACTOR shall submit Plans for this Work to ENGINEER for informational purposes only.
- E. Sheeting, shoring, and bracing, and excavation shall conform to current federal or state regulations for safety.
- F. Where indicated on the Plans and where necessary in the Work, install and leave sheeting, shoring, and bracing in place. No extra compensation shall be paid to CONTRACTOR for sheeting, shoring or bracing left in place unless otherwise indicated in the Proposal.
- G. Supports for pipes, conduits, etc., crossing the excavated area shall conform to the requirements of the owners of such facilities and if necessary, shall be left in place.
- H. Furnishing, placing, maintaining and removing of sheeting, shoring, and bracing materials shall be at CONTRACTOR's expense unless otherwise indicated in the Proposal.

- I. CONTRACTOR shall not remove the sheeting, shoring or bracing until the structure has obtained sufficient strength to support the external loads.
- J. Sheeting, shoring and bracing material shall not come in contact with the structure, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the structure.

3.03 Cofferdams

- A. A cofferdam shall consist of the maintenance, installation and removal of a substantially watertight enclosure or a well-point system or similar system, which will permit construction of the substructure, above seal or subfooting, in the dry and without damage to the Work. Alternate methods, where used in lieu of cofferdams, will be permitted by authorization only. Such authorization will be considered only after receipt of a permit from federal, local or State agencies with jurisdiction for the alternate method.
- B. Stream diversion and earth dikes, where used in lieu of cofferdams or a well-point system will be permitted by authorization only. Such authorization will be considered only after receipt of a permit from federal, local or State agencies with jurisdiction for such construction.
- C. Interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit dewatering outside of the forms.
- D. Cofferdams, caissons or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.
- E. Cofferdams shall not be braced to substructure forms. They shall be constructed so as to protect the Work in place against damage from high water and to prevent injury to the foundation by erosion. No timber bracing shall extend into or remain in the finished concrete.
- F. Cofferdams shall be removed in such a manner as not to disturb or mar the finished concrete. When called for on the Plans or where necessary in the Work, cofferdam sheeting shall be left in place.
- G. Furnishing, construction, maintenance and removal of the cofferdams including pumping shall be at CONTRACTOR's expense. If CONTRACTOR elects to use a well-point system or similar system, he shall be responsible for any claims for damages resulting therefrom.

3.04 Excavation

- A. Excavation shall include the site clearing and grubbing, the excavating and disposing of materials encountered, the supporting and protecting of structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site.
- B. Excavation shall also include the removal of existing structures, as shown on the Plans or as determined by ENGINEER.
- C. Rock excavation, if applicable, shall be performed as a part of the excavation in accordance with specifications contained elsewhere.

- D. CONTRACTOR shall keep the limits of excavation operations within a reasonable close conformity with the location and grade, of each structure.
- E. Excavated materials shall be temporarily stored in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property or traffic. The excavated materials shall not be placed at such locations that will endanger the banks of the excavation by imposing loads thereon.
- F. Excavation shall be of sufficient size to allow for the construction of the new Work, the placing and compacting of the backfill and for the dewatering operation.
- G. When concrete is to bear on or against an excavated surface other than rock, special care shall be taken not to disturb the surface. The final removal of the foundation material to grade shall not be made until just prior to the placing of the concrete.
- H. Concrete shall not be placed until the depth of the excavation has been checked and the suitability of foundation material has been reviewed by ENGINEER.
- I. Excavated material, determined by ENGINEER as suitable for backfill may be used. Excess materials shall be disposed by CONTRACTOR, at CONTRACTOR's expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- J. Elevations for the bottom of footings shall be subject to such changes as are necessary to insure a satisfactory foundation. Changes required shall be reviewed by ENGINEER prior to making the change.
- K. Surface of all rock or other hard material upon which concrete is to be placed shall be free of loose fragments, cleaned and cut to a firm surface. The surface shall be level, stepped or serrated, as shown on the Plans.
- L. Unsound material underlying proposed structures shall be removed and replaced with granular material approved by ENGINEER, in layers not exceeding six (6) inches (150 mm) in depth. Each layer shall be compacted to 95% of maximum unit weight unless indicated otherwise on the Plans, or within these specifications.

3.05 Backfill

- A. Backfill material shall be placed only after the new Work and backfill material have been inspected by ENGINEER.
- B. Backfill shall not be placed against any portion of the new Work until the required curing, surface finishing and waterproofing of such portions have been completed. Backfill which will place an unequalized horizontal loading on the new Work shall not be placed until the concrete has attained at least 70% of its design strength. To equalize horizontal loadings, the required backfill around the new Work shall be placed on opposite sides at the same time.
- C. Granular material shall be used for backfilling within three (3) feet (1 m) of manholes, chambers, valve wells, valve boxes, other pipeline structures, footings, piers, abutments, columns, walls, foundations, etc., unless otherwise indicated in the Contract Documents.
- D. Spaces excavated and not occupied by the new Work or by the specified backfill material, shall be backfilled with suitable material from the excavation.

- E. After the backfill has been placed and compacted to the flow line elevation of any weep holes indicated on the Plans, the back end of each weep hole shall be covered with not less than two (2) cubic feet (0.5 m³) of coarse aggregate.
- F. Large stones, boulders, broken rocks, concrete, and masonry shall not be used in the backfill.
- G. Backfill shall be carried up to the surface of the adjacent ground or to the elevation of the proposed earth grade, and its top surface shall be neatly graded. Fills around all new Work shall be trimmed to the lines shown on the Plans or as directed by ENGINEER.

3.06 Compacting Backfill

- A. Backfill behind and around the new Work shall be placed in layers, not more than nine (9) inches in depth and shall be compacted to not less than 95% of the maximum unit weight.
- B. Areas where the density does not affect the construction, as determined by ENGINEER, shall be compacted to not less than 90% of maximum unit weight.
- C. Backfill material shall be placed as specified in MDOT, Section 206.03.B, except for the following modifications. Backfill material shall have a moisture content not greater than three (3) percent above optimum, at the time of compaction. If the material contains an excess of moisture, it shall be dried to the required moisture content before being installed.
- D. Each layer of material containing the required amount of moisture shall be compacted to not less than 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by ENGINEER, before the succeeding layer is started.
- E. Compaction of the backfill will not be paid for separately, but shall be considered incidental to the Work of backfilling and shall include the Work of manipulating the soil to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.07 Cleanup

- A. Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by CONTRACTOR, at CONTRACTOR's expense, as specified in Section 01 8900, Site Construction Performance Requirements.
- B. Construction area shall be graded and left in a neat, workmanlike condition.
- C. At a seasonally correct time, the disturbed area shall be raked, having topsoil placed thereon, fertilized and restored per the requirements of Section 32 9219, Seeding, or Section 32 9223, Sodding.

3.08 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density of the backfill. The taking of samples and the testing required shall be performed by a testing laboratory approved by ENGINEER. The cost for testing and sampling shall be at the expense of OWNER.
- B. Testing laboratory shall furnish ENGINEER with two (2) certified copies of the results of tests. Testing procedures shall conform to current MDOT, Standards for Construction.

C. Maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method A, for granular materials conforming to MDOT, Class I, and Method D, for granular materials and all other soils.

3.09 Defective Work

A. Any portion of the backfill which is deficient in the specified density shall be corrected by the methods meeting the approval of ENGINEER. Extra testing or sampling required because of apparent deficiencies shall be at CONTRACTOR's expense.

End of Section

Section 31 2319 Dewatering

Part 1 General

1.01 Scope of Work

- A. This Section includes dewatering work, which includes well pointing, pumping, bailing and cleaning, complete, with design of dewatering systems, construction and operation of dewatering systems, abandonment of dewatering systems, protection of personnel and structures, environmental protection and restoration.
- B. CONTRACTOR will be held to have compared the conditions of the site where work is to be performed with the Drawings and Specifications and to have evaluated the conditions of the site, existing conditions, and any other conditions affecting the carrying out of the work, before delivery of CONTRACTOR's Proposal. It is expressly understood that CONTRACTOR will obtain firsthand information concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials and concerning other local conditions that may affect CONTRACTOR's work.
- C. CONTRACTOR shall draw CONTRACTOR's own conclusions as to soil and groundwater conditions to be encountered and CONTRACTOR shall complete the work under any job or field condition which was present and/or ascertainable prior to bidding.
- D. CONTRACTOR shall also complete the work under whatever conditions CONTRACTOR may create by CONTRACTOR's own sequence of construction, construction methods, or other condition he may create at no additional cost to OWNER.
- E. CONTRACTOR shall be solely responsible for evaluating the suitability of CONTRACTOR's dewatering methods with the Plans, Specifications and soil information provided by OWNER for bidding purposes. If applicable, CONTRACTOR shall also obtain County records as to the depth of wells providing water to the community or private individuals within the area affected by the dewatering operation if this information is not included in the Contract Plans or Specifications. CONTRACTOR shall be prepared to supply potable water within forty-eight (48) hours to all parties affected by the dewatering operations and shall continue supplying water for a period of thirty (30) days after ceasing dewatering operations. Costs associated with the supplying of water shall be incidental to the work as bid.
- F. If the affected parties remain without water thirty (30) days after ceasing dewatering operations, the supplying of water and resolution of the problem will be addressed by OWNER of this project.
- G. No allowance or extra consideration on behalf of CONTRACTOR will subsequently be allowed by reason of error or oversight on the part of CONTRACTOR.
- H. Work shall be done in a thorough and workmanlike manner and in conformance with accepted good practices and requirements of local, state, and federal authorities having jurisdiction.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements

- C. Section 31 2316: Structural Excavation and Backfill
- D. Section 31 2333: Trenching and Backfilling
- E. Section 03 3000: Cast-In-Place Concrete

1.03 Design of Dewatering Construction

- A. Geotechnical investigations made in relation to this Project are provided as reference documents. Interpretation of data and reports, performing additional investigations, and obtaining additional data for construction purposes is the responsibility of CONTRACTOR.
- B. CONTRACTOR shall be responsible for the complete design of structures and methods proposed for dewatering the project site, including the implementation of materials, tools and equipment proposed for use in the Work. Temporary wiring associated with the dewatering shall comply with applicable portions of the National Electrical Code.
- C. CONTRACTOR shall provide monitoring wells as necessary to determine the groundwater levels along the alignment and shaft locations.

1.04 Soil Erosion and Sedimentation Control

- A. Dewatering systems design and construction shall conform to the provisions of Part 91 Soil Erosion and Sedimentation Control, of Act 451 "Natural Resources and Environmental Protection Act" PA 451 of 1994; and Section 01 5713, Temporary Erosion and Sediment Control. Where applicable, CONTRACTOR shall obtain and pay for permits and inspections for dewatering construction in accordance with the provisions of PA 451, State of Michigan, 1994, and local government agencies having jurisdiction. No additional claim for compensation shall be allowed because of CONTRACTOR's failure to obtain or pay for such permits and inspections.
- B. CONTRACTOR, at CONTRACTOR's expense, 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 ENGINEER. 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. Also, the measures should include provisions to reduce erosion by the wind of areas stripped of vegetation, including material stockpiles.

1.05 Federal, State, and Local Regulations

- A. Dewatering operations shall conform to the requirements of federal, state, and local agencies having jurisdiction.
- B. Dewatering water discharged to streams, drains or sewers may require permits from federal, state or local agencies having jurisdiction. CONTRACTOR shall comply with all water quality requirements prior to discharging dewatering water. CONTRACTOR shall be responsible for testing and treatment required to meet water quality requirements prior to discharge. No discharges to sanitary sewers will be allowed without prior approval of local agencies with jurisdiction for the sanitary sewers.

1.06 Protection

A. Take steps necessary, during the Work of this Section, to protect surrounding property and adjacent buildings, private water supplies, roads, drains, sewers, structures and appurtenances. Adequate measures shall be taken to protect such property and construction from the effects of the dewatering operations.

1.07 Submittals

- A. Submit detailed plans indicating proposed type and location of dewatering wells, type and location of collection/conveyance piping, and point of disposal of pumped water. Do not begin any dewatering work until submittals and supporting data have been reviewed by ENGINEER.
- B. Dewatering system shall be designed by a professional with a minimum of seven years documented experience in the installation and design of dewatering systems. Submittal shall be signed and sealed by a registered professional engineer, stating that the proposed dewatering method is adequate to perform the required tasks.

Part 2 Products (Not Used)

Part 3 Execution

3.01 General

- A. Provide electrical power from local utility. Provide stand-by power and any other required auxiliary dewatering equipment to assure continuous dewatering capability. Dewatering, where required, shall be continuous. Dewatering will not be stopped during work stoppage without approval of ENGINEER. Coordinate construction operations to minimize duration and extent of dewatering required.
- B. Dewatering wells are to use properly designed filters to prevent the migration of soil fines into the well.

3.02 Monitoring and Control

- A. During dewatering operations, monitor ground water level with piezometers to ensure the design or specified groundwater elevation is maintained. Install monitoring wells with screens below the excavation level as required. Install wells at minimum 200-foot intervals located between dewatering wells. Provide access to monitoring wells by ENGINEER.
- B. Modify dewatering operation if geotechnical instrumentation or survey measurements indicate movement of structures, sheeting or embankments, or inability to lower groundwater as specified.
- C. Inspect wells and lines on a daily basis to ensure integrity and watertightness. Keep fittings and connections watertight to ensure release of sulfide to atmosphere from groundwater does not occur.

3.03 Existing Drainage Conditions

A. Prior to beginning any work, verify in the field the location, type and capacity of existing drainage facilities and conditions which will affect the Work of this Section. No allowances shall be made for conditions found during the progress of the dewatering operations because of CONTRACTOR'S failure to verify such conditions.

3.04 Existing Structures and Utilities

A. CONTRACTOR shall make field verification of all existing structures and utilities at the site of the Work which are scheduled to remain and which may be affected by the Work of this Section.

B. CONTRACTOR shall be responsible for damage to existing structures and/or utilities caused because of CONTRACTOR's construction activities and shall repair such damage at CONTRACTOR's expense to the satisfaction of ENGINEER or utility owner.

3.05 Pumping

A. Equipment for pumping and pumping methods associated with dewatering systems shall be the responsibility of CONTRACTOR and shall be acceptable to ENGINEER. CONTRACTOR shall construct or furnish adequate discharge piping to conduct and dispose of the water so as to prevent damage to existing structures or property. Pumping equipment shall be first class, acceptable to ENGINEER, of proper type and size for the Work and in good condition. Provide anchors and supports for pumping equipment.

3.06 Removal of Water

- A. Ample means and devices shall be provided and maintained at all times during the life of this Contract to remove and properly dispose of ground water and drainage water within, around, and entering the excavated area(s). The excavation and the structures within shall be kept dry until the work is completed, or as approved by OWNER.
- B. The water level within and below work areas shall be so maintained that there is no unbalanced upward pressure on the bottom of structures, sewers, or open excavations during the construction period. CONTRACTOR shall provide means within the excavation to enable OWNER to monitor the elevation of the artesian groundwater, if present. The level of the artesian groundwater shall be maintained by CONTRACTOR 's methods to prevent the possibility of upward movement of the structure or earth within the excavation area. Water levels shall be maintained to meet the approval of OWNER.
- C. In addition, water that may occur during excavation for base slabs, pipe trenches, etc., shall be channeled to accumulate in certain low points and disposed of through a filtering device before entering into sewers, streams, or rivers in accordance with Section 01 5713, Temporary Erosion and Sediment Control.
- D. CONTRACTOR shall determine the extent of dewatering required to complete the work and shall include all dewatering costs as incidental to the work as bid, unless provided otherwise in the Proposal.
- E. Excavation dewatering shall be routed as necessary so as not to impede construction. In any event, all pumping and drainage shall be done without damage to any other property, public or private, and without interference with the rights of the public or private property owners.
- F. CONTRACTOR shall receive no extra compensation for providing, maintaining or operating any dewatering or drainage facilities. The removal or stoppage of artesian water which, if any, might occur in the work shall be deemed to be covered by this Section of the Specifications unless provided for otherwise in the Proposal.
- G. On completion of this project CONTRACTOR shall fill all dewatering depressions and withdraw all dewatering facilities and drainage devices and restore the area to an acceptable condition, as approved by OWNER.

- H. Discharge of dewatering shall be to either existing storm sewer catch basins or to other drainage courses that are appropriate for this use. CONTRACTOR shall employ appropriate use of soil erosion and sediment controls on dewatering discharge including use of a sediment filter and/or an impounding area upstream of the storm sewer.
 - 1. Inspect the dewatering site several times daily to ensure that the pumping is adequately controlling the excess water, that any filters are not clogged, ripped, or torn, and that the discharge point is free of visible evidence of suspended sediment from the dewatering effort.
 - 2. If any filters become clogged, they shall be immediately replaced and additional sediment controls added upstream to prevent continued excess accumulation of sediment.
 - 3. Storm sewers downstream of CONTRACTOR's dewatering operations shall be cleaned after use at no additional cost to OWNER.

3.07 Filling and Grading

A. Upon completion of dewatering Work for the Project, abandon and/or fill holes, trenches, ditches and other earth excavations created by the Work of this Section and not scheduled to remain. Do filling, backfilling and grading to restore excavations and earth banks to the lines and levels indicated on the Plans and as determined by ENGINEER. Earth fills shall be compacted to a density equal to that of the surrounding undisturbed earth.

3.08 Compliance

- A. Groundwater withdrawal registration with the Department of Environment, Great Lakes and Energy (EGLE) has not been completed and is the responsibility of CONTRACTOR.
- B. CONTRACTOR shall provide receipt of this registration once complete and shall comply with provisions of the groundwater withdrawal registration.

End of Section

Section 31 2333 Trenching and Backfilling

Part 1 General

1.01 Scope of Work

A. This Section includes open trench construction for utility installation, complete with trenching, sheeting, bracing, bedding, bedding materials, backfilling, backfill materials, and compaction.

1.02 Related Work Specified Elsewhere

- A. Section 01 5713: Temporary Erosion and Sediment Control
- B. Section 01 8900: Site Construction Performance Requirements
- C. Section 31 2200: Grading
- D. Section 31 2316: Structural Excavation and Backfill
- E. Section 33 3400: Sanitary Utility Force Mains

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 ASTM International
 - 2. AASHTO American Association of State Highways and Transportation Officials
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Test Reports

- A. Testing laboratory shall provide ENGINEER with two (2) certified copies of the test results of the compaction of the backfill.
- B. Testing for compaction and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.05 Mix Design

A. Submit mix designs for any concrete or flowable fill mixtures to be used on the Project. Include certified test results for seven day and 28-day strengths, together with any technical information for admixtures.

1.06 Soil Erosion and Sedimentation Control

- A. CONTRACTOR, at his expense, 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 ENGINEER.
- B. Measures shall prevent surface runoff from carrying excavated materials into the drain, to reduce erosion of the slopes, and to prevent silting in of drain downstream of the Work.

- C. Measures should include provisions to reduce erosions by the wind of all areas stripped of vegetation, including material stockpiles.
- D. Comply with requirements of Section 01 5713, Temporary Erosion and Sediment Control.

Part 2 Products

2.01 Class II Granular Materials

A. Class II granular material gradation shall conform to the grading requirements for granular material Class II, as specified in MDOT, Section 902 except as follows. Class II granular material shall be natural bank run sand with a maximum size of 1½-inches (38 mm).

2.02 Crushed Stone Bedding

A. Crushed, angular, natural stone material, meeting the requirements of MDOT 21AA. Crushed concrete and slag are not allowed.

2.03 Concrete

 Concrete shall conform to MDOT, Section 701, use grade S3; 3,000 psi (21 MPa) strength; Type I-A cement; 5.5 sacks cement per cubic yard (307 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's review.

2.04 Flowable Fill for Backfilling

- A. Materials:
 - 1. Fly Ash: Fly Ash shall have a maximum loss on ignition of 12% and meet the other requirements of ASTM C618 (Class F).
 - 2. Water: Water shall meet the requirements of ASTM C94.
 - 3. Cement: ASTM C150 or C595, Type I or IA.
- B. Mixture (Strength 100 120 psi, (690 825 kPa)):
 - 1. Fly Ash: 2000 lbs/c.y. (1190 kg/m³) min
 - 2. Cement: 70 lbs/c.y. (40 kg/m³) min
 - 3. Water: Sufficient water to produce desired flowability, 700 lbs/c.y. (415kg/m³) ±
- C. Temperature of the flowable fill mix as manufactured and delivered shall be at least 50 degrees Fahrenheit (10 degrees Celsius). Flowable fill can be mixed by pugmill, central concrete mixer, ready mix truck, turbine mixer, or other acceptable equipment or method.

Part 3 Execution

3.01 Dewatering

- A. Area within the vicinity of the trenching operation shall be dewatered in accordance with Section 31 2319, Dewatering prior to the trenching operation.
- B. Depth of the dewatering shall be sufficient to allow the trench excavating operation including backfilling and compacting to proceed in a dry condition.

3.02 Trench Excavation

- A. Open cut trench excavation shall include the site clearing and grubbing, the excavating of all materials encountered, the supporting and protecting of all structures and/or utilities encountered above and below the ground surface, and the removal of water from the construction site.
- B. Trenching operation shall commence at the downstream or outlet end of the new Work and proceed upstream, unless otherwise specified on the Plans or directed by ENGINEER.
- C. Trench shall be excavated in reasonably close conformity with the lines and grades specified on the Plans or as established by ENGINEER.
- D. Excavated materials shall be temporarily stored along the trench in a manner that will not cause damage to trees, shrubs, fences, improvements, utilities, private property, public property or traffic. The excavated materials shall not be placed at such locations that will endanger the trench banks by imposing loads thereon.
- E. Trench shall be of sufficient width to provide adequate working space to permit the installation of the pipe and the compaction of the bedding material under and around the pipe. However, for rigid pipe, the width of the trench from below the pipe bedding to 12 inches (300 mm) above the top of the pipe shall not exceed the following dimensions:

| Diameter of Pipe | Width of Trench |
|--|--|
| 6-inch thru 12-inch pipe (150 thru 300 mm) | 30 inches wide (750 mm) |
| 15-inch thru 36-inch pipe (375 thru 900 mm) | outside diameter plus 16 inches (400 mm) |
| 42-inch thru 60-inch pipe (1050 thru 1500mm) | outside diameter plus 20 inches (500 mm) |
| over 60-inch pipe (1500mm) | outside diameter plus 24 inches (600 mm) |

- F. Support the additional load of the backfill when the maximum trench width as specified for rigid pipe is exceeded, CONTRACTOR shall install, at his expense, concrete encasement which shall completely surround the pipe and shall have a minimum thickness at any point of 1/4 of the outside diameter of the pipe or four (4) inches (100mm), whichever is greater, or at his expense, install another type bedding, approved by ENGINEER. Concrete encasement shall consist of 3,000 psi (21 MPa) strength concrete.
- G. For flexible pipe, the minimum width shall be not less than the greater of either the pipe outside diameter plus 16 in. (400 mm) or the pipe outside diameter times 1.25, plus 12 in. (300 mm). Maximum trench width for flexible pipe shall not exceed the minimum width by more than 6-inches.
- H. To support the additional load of the backfill when the maximum trench width as specified for flexible or semi-rigid pipe is exceeded, CONTRACTOR shall install, at his expense, crushed stone pipe bedding to the full width between undisturbed trench walls or at least 2.5 pipe diameters on each side of the pipe.
- I. When through, CONTRACTOR's construction procedure or because of unsuitable existing ground conditions, it becomes impossible to maintain alignment and grade properly, CONTRACTOR, at his expense, shall excavate below the normal trench bottom grade and shall fill the void with a large size aggregate or 3,000 psi (21 MPa) concrete as approved by ENGINEER to ensure that the pipe when laid in the proper bedding will maintain correct alignment and proper grade.

J. Trench excavations, including those for shafts and structures, shall be adequately braced and/or sheeted where necessary to prevent caving or squeezing of the soil.

3.03 Sheeting, Shoring, and Bracing

- A. CONTRACTOR shall furnish, place and maintain at all times such sheeting, shoring, and bracing of the trench and/or shaft as may be required for safety of the workmen and for protection of the new Work or adjacent structures, including pavement, curbs, sidewalks, pipelines, conduits next to or crossing the trench, and the protection and safety of pedestrian and vehicular traffic.
- B. CONTRACTOR shall be responsible for the complete design of all sheeting, shoring and bracing Work. The design shall be appropriate for the soil conditions, shall be of such strength, quality, dimension and spacing as to prevent caving or loss of ground or squeezing within the neat lines of the excavation, and shall effectively restrain movement of the adjacent soil. Prior to installing the sheeting, shoring or bracing, CONTRACTOR shall submit Plans for this Work to ENGINEER for informational purposes only.
- C. Sheeting, shoring, bracing, and excavation shall conform to the current federal or state regulations for safety.
- D. Where indicated on the Plans and where necessary in the Work, install and leave sheeting, shoring, and bracing in place. No extra compensation shall be paid to CONTRACTOR for sheeting, shoring or bracing left in place.
- E. Supports for pipes, conduits, etc., crossing the trench shall conform to the requirements of the owners of such facilities, and if necessary, shall be left in place.
- F. The furnishing, placing, bracing, maintaining, and removing of sheeting, shoring, and trenching materials shall be at CONTRACTOR's expense. CONTRACTOR shall not remove the trench sheeting, shoring and bracing unless the pipe has been properly bedded, and the trench backfilled to sufficiently support the external loads. Also the sheeting, shoring, and bracing material shall not come in contact with the pipe, but shall be installed so that no concentrated loads or horizontal thrusts are transmitted to the pipe.

3.04 Pipe Bedding

- A. Install and compact in six inch layers. Particular care shall be taken to assure filling and tamping all spaces under, around, and above the top of the pipe. Work in and around pipe by hand to provide uniform support.
- B. Rigid Pipe Bedding:
 - 1. Rigid pipe bedding shall conform to ASTM C12, except as noted.
 - a. Class R-A:
 - (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/4 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. The top half of the pipe shall be covered with a monolithic plain concrete arch having a thickness of at least four (4) inches (100 mm) or 1/4 of the inside diameter of the pipe, whichever is greater, at the pipe

crown and a minimum width equal to the outside diameter of the pipe plus eight (8) inches (200 mm) or 1-1/4 of the diameter of the pipe, whichever is greater.

- b. Class R-B:
 - (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 inches (300 mm) above the top of the pipe shall be Class II granular material. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

c. Class R-C:

(1) Pipe shall be bedded in Class II granular material, placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and the bedding shall extend to a level not less than 12 inches (300 mm) above the top of the pipe. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

C. Flexible Pipe Bedding:

- 1. Flexible pipe bedding shall conform to ASTM D2321, except as noted. Continuous and uniform bedding shall be provided in the trench for all buried pipe.
 - a. Class F-I:
 - (1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), and shall extend up the sides of the pipe until the top of pipe is covered by a minimum thickness of 12 inches (300 mm).
 - (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

b. Class F-II:

(1) Pipe shall be bedded in crushed stone bedding material placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm), or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 inches (300 mm) above the top of the pipe shall be Class II granular material. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of pipe.

- (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.
- c. Class F-III:
 - (1) Pipe shall be bedded in Class II granular material, placed on the trench bottom. Bedding shall have a minimum thickness beneath the pipe of four (4) inches (100 mm) or 1/8 of the outside diameter of the pipe, whichever is greater, and the bedding shall extend to a level not less than 12 inches (300 mm) above the top of the pipe. This material shall be placed in 6-inch (150 mm) layers with each layer thoroughly compacted by mechanical means with the finished compacted material a minimum of 12 inches (300 mm) above the top of the pipe.
 - (2) Where allowable trench widths are exceeded, Class F-I bedding shall be used to the full width between undisturbed trench walls. Concrete cradle bedding shall not be used.

3.05 Backfilling Trenches

- A. Backfill material shall be placed on sections of bedded pipes only after such pipe bedding and backfill materials have been approved by ENGINEER.
- B. Trench backfilling shall follow the pipe laying as closely as possible. However, at no time shall the pipe laying in any trench precede backfilling of that trench by more than 100 feet (30 m), unless otherwise directed by ENGINEER.
- C. Backfilling shall not be done in freezing weather except by permission of ENGINEER. Frozen materials shall not be used in trench backfilling.
- D. Following trench backfill specifications are for use in that portion of the trench beyond the scope of the pipe bedding requirements which normally stops at a point 12 inches (300 mm) above the top of pipe.
 - 1. Backfill material to be placed above pipe bedding shall be free of cinders, ashes, refuse, boulders, roots, stumps, trees, timbers, brush, debris, or other extraneous materials which in the opinion of ENGINEER, are unsuitable.
 - 2. Rocks or stones having a dimension larger than six (6) inches (150 mm) shall not be placed within three (3) feet (1 m) of the top of the pipe.
 - 3. Large stones may be placed in the remainder of the trench backfill only if well separated and arranged so that no interference with backfill settlement will result.
- E. The type and method of backfilling is dependent on its location and function and shall conform to the following requirements:

- 1. Trench "A":
 - a. All other trenches shall be backfilled with suitable excavated material placed in uniform layers that can be adequately compacted and tested from the surface of that layer. Each layer shall be thoroughly compacted by approved mechanical methods to a density equivalent to the undisturbed adjacent soil or 90% of its maximum unit weight which ever is less.
- 2. Trench "B":
 - a. Trenches under road surfaces, pavement, curb, driveway, sidewalk and where the trench edge is within three (3) feet (1m) of the pavement and as noted on the plans shall be backfilled with natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans. The material shall be placed in uniform layers that can be adequately compacted and tested from the surface of that layer and shall be compacted to 95% of the materials maximum unit weight. Trenches under pavement to be constructed in the near future, as noted or shown on the Plans, shall be backfilled with natural bank run sand, meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, as herein provided.
 - b. Where a pipe is installed under an existing or proposed utility, the backfill between the two shall be natural bank run sand meeting the requirements of Class II granular material, unless otherwise indicated on the Plans, constructed as herein specified.
- F. Unless otherwise specified on the Plans or as directed by ENGINEER, the trench backfill shall be carried to the adjacent existing ground.
- G. Where any backfill or bedding as shown on the plans or specified is to be flowable fill, care shall be used to avoid displacing any pipes or structures due to fluid pressure. Pipes in backfill areas may need to be secured to avoid the bouyancy effect.

3.06 Compacting Trench "B" Backfill

- A. Trench "B" backfill shall be compacted to 95% of the maximum unit weight, unless otherwise specified on the Plans or authorized by ENGINEER.
- B. Compaction of the backfill will not be paid for separately but shall be considered incidental to the Work of backfilling and shall include all the Work of manipulating the soil, to obtain the specified densities. No additional compensation will be allowed for any delay required to obtain the specified moisture content or the specified density.

3.07 Cleanup

- A. Immediately following the placing and compacting of the backfill, the excess material shall be removed and disposed of by CONTRACTOR, at his expense, as specified in Section 01 8900, Site Construction Performance Requirements. The construction area shall be leveled and left in a neat workmanlike condition.
- At a seasonally correct time, approved by ENGINEER, the disturbed area shall be raked, having topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding.

3.08 Field Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density of the backfill. Taking of samples and the testing required shall be performed by a testing laboratory suitable to OWNER and approved by ENGINEER. The cost for testing and sampling shall be at the expense of OWNER.
- B. Maximum unit weight, when used as a measure of compaction or density of soils, shall be understood to mean the maximum unit weight per cubic foot or per cubic meter as determined by ASTM D1557, Method D.

3.09 Defective Work

- A. Any portion of the trench backfill which is deficient in the specified density shall be corrected by methods meeting the approval of ENGINEER.
- B. Any extra testing or sampling required because of deficiencies shall be at CONTRACTOR's expense.

End of Section

Division 32 Exterior Improvements

Section 32 1123 Aggregate Base Courses

Part 1 General

1.01 Scope of Work

A. This Section includes aggregate base courses complete with aggregate materials constructed in preparation for paving or aggregate surfacing.

1.02 Related Work Specified Elsewhere

- A. Section 01 8900: Site Construction Performance Requirements
- B. Section 31 2313: Subgrade Preparation
- C. Section 32 1216: Bituminous Paving

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 ASTM International
 - 2. AASHTO American Association of State Highways and Transportation Officials
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

A. Finished surface shall be shaped to conform to plan grade and cross section within a tolerance of 3/4 inch in ten (10) feet (30 mm per 5 m).

1.05 Test Reports

A. Testing lab shall provide ENGINEER with two (2) certified copies of the test results of the thickness of the compacted aggregate. Core drilling, testing for thickness and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Stockpiling Aggregate

- A. Aggregate shall be deposited in stockpiles in such a manner that the material may be removed from the stockpile by methods which will provide aggregate having a uniform gradation.
- B. Stockpiling of aggregate, in excess of four (4) feet (1.2 m) in depth, on the completed subbase or aggregate surface will not be permitted, except with the approval of ENGINEER.

1.07 Environmental Requirements

A. Comply with the requirements for aggregate base or surfacing installations due to outside ambient air temperatures specified under Article 3.08 of this Section.

Part 2 Products

2.01 Dense-Graded Aggregate

A. Dense-graded aggregate gradation shall conform to Series 21and 22, as specified in MDOT, Section 902.

2.02 Calcium Chloride Additives

A. Calcium chloride additives shall conform to ASTM D98 and as specified in MDOT, Section 903.

2.03 Water

A. Water used for compaction and dust control shall be reasonably clean and free from substances injurious to the finished product. Water from sources approved by the Michigan State Department of Public Health as potable may be used.

Part 3 Execution

3.01 Excavation Verification

A. Prior to the placing of any aggregate material, examine the excavation for the grades, lines, and levels required to receive the new Work. Ascertain that all excavation and compacted subgrades or subbases are adequate to receive the new Work. Correct all defects and deficiencies before proceeding with the Work.

3.02 Subgrade Conditions

A. Prior to the placing of any aggregate material, examine the subgrade or subbase to ascertain that it is adequate to receive the aggregate to be placed. If the subgrade or subbase remains wet after all surface water has been removed, ENGINEER may require the installation of edge drain.

3.03 Existing Improvements

A. Investigate and verify locations of existing improvements, including structures, to which the new Work will be in contact. Necessary adjustments in line and grade, to align the new Work with the existing improvements must be approved by ENGINEER, prior to any changes.

3.04 Preparation of Subgrade or Subbase

A. Subgrade or subbase shall be fine graded to the cross section indicated on the Contract Drawings and shall be thoroughly compacted prior to the placing of the aggregate material.

3.05 Installation - General

- A. Width, thickness, and type of aggregate materials shall be indicated on the Contract Drawings or as directed by ENGINEER.
- B. No aggregate material shall be placed until the subgrade, or subbase, or existing aggregate surface has been approved by ENGINEER.

3.06 Installation of Aggregate Base Course

- A. Aggregate base course shall be placed by a mechanical spreader or other approved means, in uniform layers to such a depth that when compacted, the course will have the thickness shown on the Contract Drawings.
- B. Depth of any one layer, when compacted, shall not be more than 8 inches (200 mm). If the required compaction cannot be obtained for the full depth of the aggregate course spread, the thickness of each course shall be reduced or, with the approval of ENGINEER, adequate equipment shall be used to compact the aggregate to the required unit weight.
- C. The subgrade or subbase shall be shaped to the specified crown and grade and maintained in a smooth condition. If hauling equipment causes ruts or holes in the subgrade or subbase, the hauling equipment will not be permitted on the subgrade or subbase but shall be operated on the aggregate base course behind the spreader.
- D. Aggregate shall be compacted to at least 98% of maximum unit weight by the use of approved pneumatic-tired compaction equipment or vibratory compactors.
- E. Optimum moisture content shall be maintained until the prescribed unit weight is obtained and each layer shall be compacted until the maximum unit weight is attained before placing the succeeding layer.
- F. When approved by ENGINEER, additional water may be applied by an approved means, to the aggregate to aid in the compaction and shaping of the material.
- G. Motor graders, trimmers or other approved equipment shall be used to shape the aggregate base course and maintain it until the surface course is placed.
- H. When hauling material over the base course, subbase or subgrade, CONTRACTOR shall limit the weight and speed of his equipment to avoid damage to the subgrade, subbase or aggregate base course. If the subgrade, subbase or aggregate base course becomes rutted due to CONTRACTOR's operation, the subgrade, subbase or base course shall be removed and replaced, acceptable to ENGINEER, at CONTRACTOR's expense.
- I. With the approval of ENGINEER, chloride additives may be used by CONTRACTOR to facilitate his compaction and maintenance of the aggregate surface. Amount and method of combining the chloride additives are at the option of CONTRACTOR and are at his expense.

3.07 Maintenance During Construction

- A. Aggregate base course and aggregate surface shall be continuously maintained in a smooth and firm condition during all phases of the construction operation.
- B. CONTRACTOR, at his expense, shall provide additional materials needed to fill depressions or bind the aggregate.

3.08 Temperature Limitations

- A. Aggregate materials shall not be placed when there are indications that the mixtures may become frozen before the maximum unit weight is obtained.
- B. In no case shall the aggregate be placed on a frozen subgrade or base course unless otherwise directed by ENGINEER.

3.09 Testing

- A. During the course of the Work, ENGINEER may require testing for compaction or density and for thickness of material. Testing and coring required shall be performed by a testing laboratory acceptable to OWNER and approved by ENGINEER. Cost for testing and coring shall be at the expense of OWNER.
- B. When thickness tests are done, a minimum of one depth (thickness) measurement will be made every 400 linear feet (120 m) per traffic lane. Lane width shall be as indicated on the Contract Drawings or as determined by ENGINEER.
 - 1. If 2 lanes are constructed simultaneously, only one test is necessary to represent both lanes.
 - 2. For areas such as intersections, entrances, cross-overs, ramps, widening strips, acceleration and deceleration lane, at least one depth measurement will be taken for each 1,200 square yards (1000 m²) of such areas or fraction thereof.
 - 3. Location of the depth measurement will be at the discretion of ENGINEER.
- C. The maximum unit weight shall be understood to mean the maximum unit weight per cubic foot (or cubic meter) as determined by ASTM D1557, Method D.

3.10 Defective Work

- A. Thickness:
 - 1. Measurements of aggregate base course thickness will be made to the nearest 1/4 inch (5 mm).
 - a. Depths may be 1/2 inch (10 mm) less than the thickness indicated on the Contract Drawings provided that the average of all measurements taken at regular intervals shall be equal to or greater than the specified thickness.
 - b. In determining the average in place thickness, measurements which are more than 1/2 inch (10 mm) in excess of the thickness indicated on the Contract Drawings will be considered as the specified thickness plus 1/2 inch (10 mm).
 - 2. Locations of the depth measurements will be as specified herein unless otherwise directed by ENGINEER. Sections found to be deficient in depth shall be corrected by CONTRACTOR using methods approved by ENGINEER.
- B. Weight:
 - 1. When the aggregate material is measured by weight in Tons (or metric tons), the pay weights for aggregates will be the scale weight of the material, including admixtures, unless the moisture content is more than 6 percent.
 - a. Moisture tests will be made at the start of weighing operations and at any time thereafter when construction operations, weather conditions or any other cause may result in a change in the moisture content of the material.

b. If the tests indicate a moisture content in excess of six (6) percent, the excess over six (6) percent will be deducted from the scale weight of the aggregate until such time as moisture tests indicate that the moisture content of the material is not more than six (6) percent.

End of Section

Section 32 1216 Bituminous Paving

Part 1 General

1.01 Scope of Work

A. This Section includes bituminous paving complete with bituminous materials; bituminous mixtures; installation of bituminous base course, bituminous wearing course, and bituminous curbs; construction of bituminous pavement, sidewalks, drive approaches, and tennis courts, cold milling and pulverizing existing pavements.

1.02 Related Work Specified Elsewhere

- A. Section 01 8900: Site Construction Performance Requirements
- B. Section 31 1100: Clearing and Grubbing
- C. Section 31 2313: Subgrade Preparation
- D. Section 32 1123: Aggregate Base Courses

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 ASTM International
 - 2. AASHTO American Association of State Highways and Transportation Officials
 - 3. MAPA Michigan Asphalt Paving Association
 - 4. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Allowable Tolerances

- A. Following the final rolling, the surface will be tested longitudinally using a 10-foot (3 m) straightedge at locations selected by ENGINEER. Variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed the following limits:
 - 1. For Bituminous Base Course Mixtures:
 - a. Multiple Courses:
 - (1) 3/8 inch (9 mm) for top course
 - (2) 3/4 inch (20 mm) for lower courses
 - 2. For Bituminous Surface Course Mixtures:
 - a. Multiple Courses:
 - (1) 1/8 inch (3 mm) for top course
 - (2) 1/4 inch (5 mm) for lower courses
 - b. Single Course: 1/4 inch (5 mm)

B. Variations in excess of the specified tolerance shall be corrected as determined by ENGINEER.

1.05 Material Reports

- A. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the ASTM Standards referred to in the Specifications.
- B. CONTRACTOR shall provide ENGINEER, or his authorized representative, with the certified batch plant delivery tickets prior to the placing of the materials.
- C. CONTRACTOR shall supply ENGINEER with a certified job mix design for each type of bituminous mixture used on this Project.

1.06 Test Reports

A. Testing lab shall provide ENGINEER with two (2) certified copies of the test results of the mix design and the thickness of the bituminous paving material. Core drilling, testing for mix design and thickness, and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.07 Environmental Requirements

A. Comply with the requirements for bituminous concrete installation due to outside ambient air temperatures specified under Article 3.22 of this Section.

Part 2 Products

2.01 Blended Aggregate

A. The blended aggregate shall conform to ASTM D692, D1073; AASHTO M29, and as specified in MDOT, Sections 501 and 902. Aggregates for bituminous mixtures shall conform to the applicable requirements of Table A: Composition of Bituminous Mixtures and Table B: Mix Design Criteria.

2.02 Mineral Filler

A. The mineral filler gradation shall conform to AASHTO M17 and to mineral filler, 3MF, as specified in MDOT, Section 902.12.

2.03 Anti-Foaming Agents

A. The anti-foaming agents shall conform to anti-foaming agents, as specified in MDOT, Section 904.

2.04 Asphalt Binder

A. Asphalt binder for use in production of bituminous mixtures shall Be Performance Graded Asphalt Binder, PG58-28, per MDOT Section 904, unless otherwise indicated on the Plans.

2.05 Liquid Asphalts

A. Liquid asphalts for use in pavement construction shall conform to ASTM D2026, D2027, and D2028, AASHTO M81 and M82, and as specified in MDOT, Section 904.

2.06 Emulsified Asphalt (Bond Coat)

A. Emulsified asphalt for use in pavement construction shall conform to ASTM D244, and as specified in MDOT, Section 904.

2.07 Composition of Mixtures

- A. Bituminous mixtures shall be mixed and placed in accordance with applicable requirements specified in MDOT Section 501, except as otherwise specified in this Section.
- B. Blended aggregate used for the bituminous wearing course on this Project shall have an Aggregate Wear Index (AWI) of 260, or higher.
- C. Aggregates, mineral filler (if required), and asphalt binder shall be combined as necessary to produce a mixture proportioned within the master gradation range limits shown in Table A and meeting the uniformity tolerance limits shown in Table C.
- D. Composition limits in Table A are shown in percent by weight, based on the total aggregate, including mineral filler, in the mixture.
- E. Bituminous mixture specified on the Plans or in the Proposal, when tested at optimum asphalt content (determined in accordance with MDOT Procedures Manual for Mix Design Processing), shall meet the requirements for stability, flow, voids in mineral aggregate (VMA), air voids, fines/binder ratio, fine aggregate angularity, L.A. Abrasion loss, and soft particles as specified in Table B, Mix Design Criteria.
- F. Mixtures failing to meet the requirements specified in Table B will be rejected and the CONTRACTOR will be required to submit additional samples of bituminous mixtures until a combination of material is found which will produce a mixture meeting the Table B requirements.
- G. If there is a change in the source of any of the aggregates, a new job-mix formula will be required.
- H. After the job-mix formula is established, the aggregate gradation and the asphalt binder content of the bituminous mixture furnished for the Work shall be maintained within the Range 1 uniformity tolerance limits permitted for the job-mix formula as specified in Table C.
 - 1. If two (2) consecutive aggregate gradations on one (1) sieve, or asphalt binder contents as determined by the field extractions are outside the Range 1 but within the Range 2 uniformity tolerance limits, CONTRACTOR shall suspend all operations. (Work days will be charged during the down time.)
 - 2. Before resuming any production, CONTRACTOR shall make all necessary alterations to the materials or plant so that the job-mix formula can be maintained within the deviations permitted under Table C.
- I. CONTRACTOR shall provide uniformity in the gradations of the aggregates placed in the cold feed bins so that the combination of aggregates produced for the mixture by blending the aggregates from two (2) or more cold feed bins will be uniformly fed by means of adjustable feeders onto a belt supplying the asphalt plant.
 - 1. Feeders shall be equipped with cutoffs which will automatically stop the operations to the asphalt plant at any time the flow of any aggregate fraction is changed so as to affect the uniformity of the finished product.

- J. CONTRACTOR has the option of using hot bins for proportioning the aggregates to meet the specified tolerances.
- K. Aggregate gradation tests will be made on aggregate extracted from samples of bituminous mixture taken from the trucks as directed by ENGINEER. As a general guideline, samples will be taken at initial start of production and at other times when tests indicate that the aggregate gradation is fluctuating, truck samples will be taken at a frequency of one (1) sample per 250 Tons (225 metric tons) of mixture, but not more than four (4) samples per day. During other periods where tests indicate the aggregate gradation is stable, truck samples will be taken at a frequency of one (1) sample will be taken at a frequency of one (1) sample per 500 Tons (450 metric tons) of mixture, but no more than two (2) samples per day.
 - 1. Mixtures exceeding the maximum tolerances listed in Range 2 under Table C, or exceeding the maximum limits specified for the master gradation range will be rejected and CONTRACTOR may be required to remove and replace any bituminous pavements which ENGINEER determines were constructed with mixtures in the excess of these tolerances.
 - 2. Exact mixture proportions will be based on composite samples of aggregate and the particular bituminous material called for on the Plans and in the Proposal.

Part 3 Execution

3.01 Excavation

A. Prior to the installation of any bituminous concrete pavement, examine the excavation for the grades, lines, and levels required to receive the new Work. Ascertain that all excavation and compacted subgrades are adequate to receive the bituminous pavement to be installed. Correct all defects and deficiencies before proceeding with the Work.

3.02 Subgrade and Base Course Conditions

A. Prior to the installation of any bituminous pavement, examine the subgrade and base course to ascertain that it is adequate to receive the bituminous concrete pavement to be installed. If the subgrade remains wet after all surface water has been removed, ENGINEER may require the installation of edge drain.

3.03 Existing Improvements

A. Investigate and verify location of existing improvements, including structures, to which the new Work is to be connected. Adjustments in line and grade to align the new Work with the existing improvements must be approved by ENGINEER, prior to any changes.

3.04 Equipment Requirements

- A. General:
 - 1. CONTRACTOR shall furnish sufficient equipment for completing the Work in a timely and efficient manner.
 - 2. Equipment shall be on the job site and ready for normal operation before the placing of material is started.

- a. Equipment shall be in good working order and of sufficient capacity that the operation can be continuous and a rate of production obtained which insures good workmanship, and eliminates overloading of the equipment or frequent interruptions or delays..
- b. Equipment shall be subject to inspections and testing during construction.
- c. Equipment shall conform to the requirements as specified in MDOT, Section 501 and as specified herein.
- B. Pavers:
 - 1. Paver shall be an approved self-powered machine capable of spreading and finishing the mixture in a uniform layer at the desired thickness and cross section and ready for compaction. The use of any machine in poor mechanical or worn condition, will not be permitted. Paver shall be of such design that the supporting wheels, treads, or other devices ride on the prepared base. The full width of surface being applied shall be screeded by an oscillating or vibrating screed.
 - 2. Paver shall at all times produce a uniformly finished surface, free from tearing or other blemishes that would require hand work. Screed shall be adjustable to provide for tilting to secure the proper dray or compressive action necessary to produce the desired surface texture.
 - 3. Paver shall be equipped with a hopper and an automatic material-depth control device so that each distributing auger and corresponding feeder shall respond automatically to provide for a constant level of mix ahead of the screed unit to the full width of the lane being paved.
 - 4. In order to ensure that adequate material shall be fed to the center portion of the lane being paved, reverse pitch augers or paddles shall be installed at the inside of one or both ends of the auger shafts to force the mix to the middle portion of the lane. If necessary to prevent segregation of the mix as it drops off the feed conveyor, baffle plates shall be installed at the required location.
 - 5. When extensions are added to the paver, they shall be provided with the same vibrating screed or tamper action as the main unit of the paver, except for paving variable width areas. Extensions shall also be equipped with a continuation of the automatically controlled spreading augers. Screed and extensions shall be provided with an approved method of heat distribution.
 - 6. Unless specified otherwise, bituminous pavers shall be equipped with an automatically controlled and activated screed and strike-off assembly capable of grade reference and transverse slope control. A manufacturer approved grade referencing attachment, not less than 30 feet (9 m) in length, shall be used for all lower courses and the first lane of the wearing course. After the first lane of the wearing course has been placed, a 10-foot (3 m), or longer, grade referencing attachment may be substituted for constructing subsequent adjacent lanes of wearing course mixture.
 - 7. A self-propelled mechanical spreader capable of maintaining the proper width, depth, and slope without causing segregation of the material, may be used for base courses and for surface courses less than eight (8) feet (2.4 m) in width.

- 8. When surfacing ramps or shoulders, or when the grade of a concrete gutter or other existing installation must be met, the manner of use of the automatic grade reference and slope control devices shall be determined by ENGINEER.
- 9. Whenever a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually for the remainder of the normal working day, provided this method of operation will produce results meeting the specification requirements.
- C. Crushing Equipment:
 - 1. Crushing equipment for pulverizing existing bituminous base course shall be an approved rotary reduction machine having positive depth control adjustments in increments of ½ inch (10 mm) and capable of reducing material which is at least six (6) inches (150 mm) in thickness. The machine shall be of a type designed by the manufacturer specifically for reduction in size of pavement material, in place, and be capable of reducing the pavement material to the specified size. Cutting drums shall be enclosed and shall have a sprinkling system around the reduction chamber for pollution control. The rate of forward speed must be positively controlled in order to ensure consistent size of reduced material. The machine must be equipped with an accurate tachometer which is mounted in full view of the operator. Crushing equipment shall meet the approval of ENGINEER.
- D. Cold Milling Machine:
 - 1. Cold Milling machine for removing concrete or bituminous surfaces shall be equipped with automatically controlled and activated cutting drums that are capable of grade reference, transverse slope control, and produce a uniformly textured surface. An approved grade referencing attachment, not less than 30 feet (9 m) in length shall be used. Equipment for removing the concrete or bituminous surface shall be capable of accurately removing the surface, in one or more passes, to the required grade and cross section.
- E. Joint Heaters:
 - 1. Joint heaters shall be infrared or other approved heaters, equipped with an automatic ignition and extinguishing system to ensure that the heater operates only when the paver is moving. It shall be of sufficient length and heating capacity to adequately soften the edge of the mat. The heater shall be oriented parallel to the joint edge. The bituminous pavement shall not be heated by a direct open flame.
- F. Rollers:
 - 1. Steel-wheel rollers shall weight at least eight (8) Tons (7 metric tons) and shall be self-propelled, vibratory or static, tandem rollers or shall be self-propelled static 3-wheel rollers.
 - a. Steel-wheel rollers shall be free from backlash, faulty steering mechanism, or worn king bolts.
 - b. Steering device shall respond readily and permit the roller to be directed on the alignment desired.
 - c. Rollers shall be equipped with wheel sprinklers and scrapers.

- d. Roller wheels shall be smooth and free from openings or projections which will mark the surface of the pavement.
- 2. Vibratory rollers shall have a shutoff to deactivate the vibrators when the roller speed is less than 0.5 mph (.8 km/hr) and shall have provisions to lock in the manufacturer's recommended speed, the vibration per minute, and the amplitude of vibration (dynamic force) for the type of bituminous mixture being compacted.
- 3. Pneumatic-tired roller shall be of the self-propelled type with a total weight, including ballast, not greater than 30 tons (27 metric tons).
 - a. It shall be equipped with a minimum of seven (7) wheels situated on the axles in such a way that the rear group of tires will not follow in the tracks of the forward group, but will be so spaced that a minimum tire path overlap of 1/2 inch (10 mm) is obtained.
 - b. Tires shall be smooth and shall be capable of being inflated to or adapted to achieve a pressure necessary to provide ground-contact pressures of at least 80 pounds per square inch (550 kPa).
 - c. Tire pressures shall not vary by more than five (5) pounds per square inch (35 kPa) between individual tires.
 - d. CONTRACTOR shall furnish a tire gage which shall be available at all times to enable NGINEER to check the tire pressures.
 - e. CONTRACTOR shall furnish ENGINEER charts or tabulations showing the contact areas and the contact pressures for the full range of tire inflation pressures and tire loadings for the type and size roller used.
- 4. Roller shall be equipped with a mechanism capable of reversing the motion of the roller smoothly. Roller shall be equipped with wheel sprinklers and scrapers or mats.
- 5. Rollers shall be of sufficient size to compact the bituminous mixture to the required density without tearing, displacing, or cracking the mat.
- G. Chip Spreader:
 - 1. Chip spreader shall be self-propelled and shall be equipped with pneumatic tires.
 - 2. Spreader shall be equipped with a screen mounted below the metering gage.
 - 3. Spreader shall be capable of spreading the cover material uniformly at widths of 3 to 12 feet (1 to 3.5 m), or separate spreaders shall be provided for the specific widths required.
 - a. Rate of discharge of the spreader shall be adjustable to spread uniform layers of 10 to 50 pounds per square yard (5 to 27 kg/m²).
- H. Bituminous Concrete Curbing Machine:
 - 1. Bituminous concrete curbing machine shall be self-propelled and shall be capable of laying and satisfactorily compacting curved and straight line curb to the cross section specified on the Plans. It shall be equipped with templates for the cross sections required.

3.05 Preparation of Foundations

- A. For bituminous base course mixtures required to be placed directly on the subgrade, the density, grade and cross section shall meet the approval of ENGINEER at the time of placement of any mixture.
- B. Prior to placing any bituminous mixture, the surface of the existing pavement including joints and cracks shall be thoroughly cleaned of all dirt and debris.
- C. Existing structures within the limits of the new Work shall be adjusted as specified in the Plans, or as directed by ENGINEER.

3.06 Preparation of Aggregate Base

- A. Prior to the placing of any prime coats or any bituminous mixtures, the density, grade and cross section of the aggregate base shall meet the approval of the ENGINEER at the time of placement of any material.
- B. Surfaces that have become too wet or too dry shall be reworked to provide the required density.

3.07 Preparation of Existing Pavement

A. This Work consists of preparation of the existing concrete road for resurfacing. All broken pavement or pavement not bonded to the base pavement, and loose bituminous surfacing or patches shall be removed. All longitudinal and transverse joints and cracks shall be cleaned in accordance with Article 3.14, Joint Cleanout. Butt joints at the end of surfacing sections and at intersections of adjoining streets shall be made in accordance with Article 3.08. Vertical face of the cut shall be maintained true, straight and undamaged until installation of wearing course.

3.08 Butt Joints

A. If butt joints are specified on the Plans, or by ENGINEER, the old surface shall be cut back for at least five (5) feet (1.5 m) to a depth of at least 1-inch (25 mm), for the full width of the joint. The vertical face of the cut shall be maintained true, straight and undamaged until installation of wearing course.

3.09 Edge Trimming

- A. Trimming and truing the edge of an existing bituminous surface shall be performed as required to give a straight, sharp edge at the proper elevations.
- B. The existing base under the bituminous surface shall be left undisturbed.

3.10 Removing Bituminous Surfacing

A. When removing an existing bituminous pavement, the edges of the area to be removed shall be cut along straight lines, either perpendicular or parallel to the direction of travel, for the full depth of the bituminous surfacing with the cut edge a minimum of 18 inches (450 mm) back from the disturbed edge of pavement.
B. The cutting of the edges and the breaking up of the bituminous material within the removal area, and the removing and disposing of the unsuitable material are included in the Work of removing bituminous surfacing.

3.11 Removing Bituminous Patches

- A. Where the removal of bituminous patching material is specified on the Plans or as directed by ENGINEER, it shall be saw cut along the edges of the patched area to prevent the tearing of the adjoining pavement surfaces during the removal operation.
- B. Cutting, removing and disposing of bituminous surfacing and unsuitable materials are included in the Work of removing bituminous patches.

3.12 Pulverization and Shaping of Existing Bituminous Base Course

- A. This Work consists of scarifying, pulverizing, milling, crushing, adding new material if required, shaping, rolling, compacting, and proofrolling the crushed base to the proper elevation and slope.
- B. Additional materials required to fill holes and voids shall be furnished at CONTRACTOR's expense. Additional aggregate, if required shall be 20A or 22A aggregate.
- C. The material shall be scarified and uniformly pulverized to a maximum size of two inches (50 mm), in addition, 95 to 100 percent of the material shall have a particle size of 1-1/2 inches (40 mm) or smaller.
- D. The material shall be scarified and uniformly pulverized, in one or more passes, to the depth specified on the Plans or as determined by ENGINEER.
- E. The maximum length or width of roadbed to be scarified and pulverized at any one time shall be as specified on the Plans or as determined by ENGINEER.
- F. The crushed material shall be rough graded to within 3/4 of an inch (20 mm) of the grade called for on the Plans, or as directed by ENGINEER. Additional aggregate shall be placed, if necessary, to attain the required cross sections.
- G. After the material has been balanced, it shall be thoroughly mixed. In restrictive areas, the material to be mixed may be bladed into a windrow to provide working room for the mixer.
- H. The mixed material shall be shaped and compacted in reasonably close conformity with the lines, grades, and cross sections shown on the Plans or as established by ENGINEER. Excess material shall be removed and disposed of by CONTRACTOR at his expense.
- I. Finished rolling shall be done with a vibratory steel wheel roller.
- J. Aggregate-bituminous pavement mixture shall be compacted to not less than 95 percent of the unit weight obtained by the AASHTO T180 test method. The test shall be made on the aggregate-bituminous mixture at the field moisture content existing during the compacting operation. Required density shall be maintained until the material has been surfaced.
- K. Prior to the placing of any surface courses, the pulverized material shall be proofrolled. Proofrolling shall be accomplished with an 18,000 pound (82 000 kg) single axle load. Unstable areas shall be removed and backfilled.

3.13 Hand Patching

- A. Where the filling of holes and depressions in the base or the replacing of the patches is specified on the Plans or as directed by ENGINEER, the filler material shall be an approved bituminous mixture.
- B. The mixture selected will be dependent on the depth and size of the patch and the type of mixture and performance grade of the asphalt binder required.
- C. Patches shall be compacted to the required grade by use of a machine vibrator or approved roller.

3.14 Joint Cleanout

- A. Where joint cleanout is specified on the Plans or as directed by ENGINEER, the joint sealants and foreign material shall be removed to a minimum depth of 1-inch (25 mm) by approved mechanical or hand methods.
- B. Removal and disposal of unsuitable materials and the removal and disposal of bituminous surface patches adjacent to joints are included in the Work for joint cleanout.

3.15 Repairing Pavement Joints

- A. Where existing pavement joints and cracks are to be repaired, as specified on the Plans or as directed by ENGINEER, the existing bituminous surface and any loose or spalled concrete around the joints and cracks shall be removed.
- B. Each joint or crack shall be cleaned and shall be filled with an approved mixture and the mixture shall be compacted with a vibratory machine or by an approved method.

3.16 Cold Milling Concrete or Bituminous Pavement

- A. Where cold milling concrete or bituminous pavement is specified, the pavement shall be milled to the shape and cross section as shown on the plans. Immediately after cold milling, the surface shall be cleaned. CONTRACTOR shall remove and dispose of any resulting debris.
- B. When allowed by ENGINEER, milling materials may be used for temporary wedging.
 - 1. Prior to placing pavement, temporary wedging materials shall be removed and disposed of.
 - 2. Wedging with milled materials is incidental to the Project.

3.17 General Bituminous Pavement Installation Requirements

- A. The width, thickness and type of bituminous paving improvement shall be specified on the Plans, indicated in the Proposal or as determined by ENGINEER.
- B. At street intersections, curb drops conforming to the current rules and regulations of Act 8, Michigan PA 1973, as amended, shall be provided for the construction of sidewalk ramps. In addition, curb drops for sidewalks and driveway approaches shall be provided in locations called for on the Plans or as determined by ENGINEER.

C. Existing improvements, including structures, shall be protected to prevent their surfaces from being discolored during application of bituminous materials.

3.18 Bituminous Prime Coat or Bond Coat

- A. The prepared foundation shall be treated with bituminous material for prime coat or bond coat as specified. A bond coat shall be applied to each layer of bituminous mixture before the succeeding layer is placed.
- B. Bituminous material shall be applied uniformly by means of a pressure distributor, and only in such areas as may be inaccessible to the regular distributor operation shall the bituminous material be applied by means of the hand spraying apparatus of the distributor.
 - 1. Where necessary to accommodate traffic, the surface shall be treated half-width or as recommended by ENGINEER.
 - 2. Foundation shall be free from moisture when the treatment is applied.
 - 3. Under no circumstances shall pools of bituminous material be allowed to remain on the surface.
- C. The amount of prime coat to be applied per square yard shall be 0.05 gal/s.y (250 ml/m²) unless otherwise specified on the Plans or recommended by ENGINEER.
- D. When prime coat is applied, the surface course shall not be placed until the prime coat has been properly cured. No blotting of the prime coat with aggregate in lieu of proper curing will be permitted.
- E. Prime coat may be omitted or reduced when authorized by ENGINEER.
- F. Bond coat shall be applied at the rate specified by ENGINEER. This rate will be between 0 and 0.10 gallons per square yard (0 to 450 ml/m²) on the bituminous or concrete foundation and between 0 and 0.05 gallons per square yard (0 to 250 ml/m²) between subsequent courses.
- G. Bond coat material shall be applied ahead of the paving operation for a distance of at least 1,500 feet (450 m), depending on traffic conditions, as determined by ENGINEER. The surfacing shall not be placed until the bond coat has cured.

3.19 Transportation of Mixtures

A. The transportation of the mixtures as specified shall be in accordance with MDOT, Section 501.

3.20 Placing Bituminous Mixtures

- A. Pavers will be required to have an automatically controlled and activated screed and strike-off assembly except when placing mixtures for:
 - 1. Variable width sections;
 - 2. Sections of pavement less than 1,000 feet(300 m) in length;
 - 3. Placing the first course of a base course mixture on an earth grade or on a sand subbase; or,

- 4. Placing base course mixtures in widths less than eight (8) feet (2.5 m).
- B. Bituminous base course mixtures shall not be placed in lifts exceeding three (3) inches (75 mm), unless otherwise approved by ENGINEER.
 - 1. Approval to place lifts in excess of three (3) inches (75 mm) will be based on the ability of CONTRACTOR to place and compact the base course to the required cross section and within the specified tolerances.
- C. For lifts of 2-1/2 inches (65 mm) or greater, a berm of shoulder material shall be banked against the outside edge of each layer of mixture placed unless the sequence of operations is such that the edges of the material are adequately confined and supported in some other manner.
 - 1. The width of material placed shall be twice the height of the bituminous layer being placed but in no case less than a 6-inch (150 mm) width.
- D. When the application rate for a bituminous wearing course exceeds 220 pounds per square yard (120 kg/m²), the pavement shall be constructed in two (2) or more courses, unless otherwise specified on the Plans or as authorized by ENGINEER.
- E. Bituminous mixture shall be placed by an approved self-propelled mechanical paver to such a depth that when compacted, it will have the thickness specified.
 - 1. The mixture shall be dumped into the center of the hopper and care shall be exercised to avoid overloading the paver and spilling the mixture upon the base.
 - 2. The paver speed shall be adjusted at the discretion of ENGINEER to that speed which, in his opinion, gives the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver to provide a uniform rate of placing the mixture without intermittent operation of the paver.
- F. When delays result in slowing paving operations such that the temperature of the mat immediately behind the screed falls below 170 degrees Fahrenheit (75 degrees Celsius), paving shall be stopped and a transverse construction joint placed.
- G. Bituminous mixture shall be placed in one (1) or more layers as called for on the Plans or as approved by ENGINEER.
 - 1. To take out irregularities in the existing road surface, wedging with bituminous mixture shall be done by placing several layers with the paver.
 - 2. Corrections to the foundation by wedging with bituminous material shall be made by placing, compacting, and allowing the material to cool prior to paving.
- H. Bituminous mixtures shall be placed using two (2) pavers in echelon or one (1) paver equipped with an approved joint heater.
 - 1. ENGINEER may omit the use of the joint heater if the temperature of the previously placed mat does not fall below 170 degrees Fahrenheit (75 degrees Celsius) prior to placement of the adjacent course.
- I. Echelon paving will be permitted when allowed by ENGINEER.

- J. Cold joints will be permitted along acceleration and deceleration lanes, lanes less than full width, irregularly shaped sections, and at transverse joints.
 - 1. Edges of the initial mat for all cold joints shall be painted with bituminous material before the bituminous mixture is placed in the adjacent section.
 - 2. In placing the bituminous mixture adjacent to all joints, hand raking or brooming will be required to provide a dense smooth connection.
- K. Connections with existing surfaces at the beginning and ending of resurfacing sections and at intersections shall be made by feathering out the mix, by constructing a butt joint, or as approved by ENGINEER.
- L. When placing the bituminous mixture in a lane adjoining a previously placed lane, the mixture shall be placed such that it uniformly overlaps the first lane by two (2) to four (4) inches (50 to 100 mm) and is placed at a height above the cold mat equal to the breakdown roller depression on the hot mat.
 - 1. Overlapping material shall be bumped, back onto the hot lane so that the roller will compress the excess material into the hot side of the joint.
 - 2. If, in the opinion of ENGINEER, the overlap is excessive, the excess material shall be trimmed so as to leave an edge having a uniform thickness.
 - 3. Excess material shall be discarded; it shall not be spread across the surface course.
- M. If the lanes are being constructed with two (2) or more pavers in echelon, the loss depths of bituminous material from each paver shall match at the longitudinal joints.

3.21 Rolling and Compacting of Bituminous Mixtures

- Each layer of bituminous mixture shall be compacted with approved rollers. At least two (2) rollers will be required when the mixture lay-down rate exceeds 800 square yards (650 m²) per hour.
- B. Steel 3-wheel rollers may be used for initial compaction immediately following the paver.
- C. The final rolling operation on each layer of bituminous mixture shall be accomplished by use of tandem steel-wheel rollers or by use of vibratory rollers operated in the static mode.
- D. Roller wheels shall be kept properly moistened with water.
- E. Pneumatic-tired rollers shall be operated in a competent manner and shall not mark or rut the surface or displace the pavement edges.
 - 1. Pneumatic-tired roller shall be ballasted to obtain the required ground-contact pressures as directed by ENGINEER.
 - 2. To obtain a uniformly textured mat and the desired pavement density, ENGINEER may recommend CONTRACTOR to raise or lower tire pressures at any time during the rolling operations.
 - 3. Roller operations shall be conducted in such a manner as to prevent scuffing or chatter marks in the pavement surface.

- 4. The number of passes made by the pneumatic-tired roller shall not be less than two (2) round trip passes over each area.
- F. Rolling of the mixture shall begin as soon after placing without undue displacement, picking up the mat, or cracking.
 - 1. Rolling shall start longitudinally at the extreme sides of the lanes and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the drive wheel of the roller.
 - 2. Alternate trips of the roller shall be of slightly different lengths.
 - 3. The maximum roller speed shall not exceed the manufacturer's recommended speed for the type of mixture or thickness of layer being placed.
- G. When compacting an adjoining lane, the longitudinal joint shall be rolled first with the roller supported mainly on the cold lane with only three (3) to six (6) inches (75 to 150 mm) of the roller extending onto the freshly placed bituminous material.
- H. Finish rolling shall continue until all roller marks are eliminated.
- I. Pneumatic-tired rollers will not be permitted on wearing courses.
- J. Areas too narrow to be rolled directly by standard 8-Ton (7 metric ton) tandem rollers shall be compacted by self-propelled trench rollers of suitable width, approved by ENGINEER, and weighting not less than 300 pounds per inch of width (5500 kg/m).
- K. Skin patching on an area that has been rolled will not be permitted. Any mixture that becomes mixed with foreign material or is in any way defective shall be removed and replaced at CONTRACTOR's expense.
- L. See Article 3.31 of this Section for compaction test.

3.22 Weather and Seasonal Limitations

- A. Bituminous mixtures shall not be placed nor the prime coat or bond coat applied when rain is threatening or when the moisture on the existing surface would prevent satisfactory bonding.
- B. Unless otherwise approved by ENGINEER in writing, minimum mixture temperature limitations at the time of placement, and seasonal limitations for placing bituminous mixtures shall be in accordance with the following:
- C. Seasonal Limitations:

| 1. | Upper Peninsula | June 1 - Oct 15 |
|----|--------------------------------|-----------------|
| 2. | Lower Peninsula, north of M-46 | May 15 - Nov 1 |
| 3. | Lower Peninsula, south of M-46 | May 5 - Nov 15 |

D. Bituminous paving will not be allowed below these minimum temperatures, nor when there is frost on the grade or existing surface.

| Mix Temperature Placement Limitations: | | | | | | | |
|--|--|----------------------|-------------|--|--|--|--|
| Temperature of Surface | Rate of Application of Bituminous Material, lbs/syd (kg/m ³) | | | | | | |
| being Overlayed °F (°C) | < 120 (65) | 120 – 200 (65 – 110) | > 200 (110) | | | | |
| 35 - 39 (2 - 4) | - | - | 329 (165) | | | | |
| 70 - 78 (21 - 25) | 302 (150) | 289 (142) | 275 (135) | | | | |
| 79 - 86 (26 - 30) | 289 (142) | 275 (135) | 275 (135) | | | | |
| 86 and Over | 275 (135) | 275 (135) | 275 (135) | | | | |

3.23 Heating Bituminous Materials

- A. Bituminous material which requires heating before application shall be heated in such a manner as to insure a uniform temperature throughout the entire mass with efficient and positive control at all times. It shall be heated to a temperature consistent with the type of material used and only to such temperature as will insure the necessary fluidity.
 - 1. Excessively high temperatures shall be avoided.
 - 2. A thermometer shall be provided to enable ENGINEER to observe the temperature at any time.
 - 3. Bituminous material which has been overheated will be rejected.
- B. Asphalt emulsion shall be circulated continuously when heated above atmospheric temperature so as to prevent it from separating.
 - 1. Heating of asphalt emulsion to the required temperature for application shall be done entirely in the distributor unless a uniform temperature is maintained in the storage tank by means of a circulating heater.
 - 2. Asphalt emulsion which has been damaged by continuous heating for too long a time or by alternate heating and cooling will be rejected.

3.24 Patching

- A. Where patching is required on a bituminous surface or concrete surface because of small holes or pitted surface, the holes shall be cleaned of all dirt and foreign material.
- B. The bituminous patching material shall be placed, struck off and compacted so that when completed, the patch shall be flush with the adjacent pavement. The compaction may be done with a hand tamper, vibratory compactor or roller.
- C. When patching is required for repairing a cut in the pavement, made for the construction of underground structures and utilities, the granular backfill shall be compacted to not less than 95% of the maximum unit weight.

An aggregate base material of not less than 12 inches (300 mm) compacted thickness, or a bituminous base of the specified thickness, shall be used. The top of the base shall be 2 to 2-1/2 inches (50 to 65 mm) below the surface of the adjacent pavement. Bituminous patching material shall be placed and compacted.

D. The surface of the bituminous patch shall be smooth and shall not vary more than 1/4 inch (5 mm) from the crown and grade of the adjacent pavement. Variations over 1/4 inch (5 mm) from the established grade shall be corrected as determined by ENGINEER

3.25 Chip Seal

- A. Seal coating shall consist of 1 or more applications of bituminous material applied to the prepared surface and 1 or more coverings of coarse or fine aggregate applied to the bituminous material.
- B. Asphalt Emulsion shall be HFRS-2M or CRS-2M and aggregate shall be MDOT 29A unless otherwise specified on the plans.
- C. Cover materials used for seal coating shall be sufficiently dry when it comes in contact with bituminous material. The moisture content shall not exceed 3 percent by weight, dry basis. Satisfactory means shall be provided for the protection of the coating materials against excessive moisture by covering stockpiles, by aeration or through manipulation.
- D. The bituminous material specified for surface coat shall be uniformly applied by means of the pressure distributor in the number of applications provided and in the amount per square yard as determined by ENGINEER. Each application of bituminous material shall cure sufficiently to prevent displacement or pickup by traffic or construction equipment before a succeeding application of bituminous material is made.
- E. Following the application of surface coat bituminous material, the cover material shall be uniformly spread over the surface by means of approved mechanical spreaders, in the amount per square yard as specified or as determined by ENGINEER. Truck wheels shall ride on spread cover material and not on bituminous material.
- F. Irregularities or deficiencies in the uniformity of the cover aggregate on the surface shall be corrected by hand spreading and dragging.
- G. Following the spreading of each course of cover material, the surface shall be rolled by means of approved rollers.
- H. Rolling shall immediately follow the placing of cover material before the bituminous material has set. At no time shall there be more than 300 feet (90 m) of unrolled cover material. No cover material shall be left unrolled for more than five (5) minutes.
- I. Sufficient rolling shall be done to embed the cover material in the bituminous material without crushing the aggregate.
- J. For areas deficient in cover material after completion of the surface treatment, additional cover material shall be added. For areas with excessive cover material, the excess cover material shall be removed before the next seal is applied. Final application of cover material shall be swept with a power broom.
- K. Completed surface shall be maintained with a drag, broom or other approved equipment to keep the material well distributed on the road until all cover material possible has been embedded in the bituminous material. The length of time required for this maintenance will be from 2 to 5 days, as determined by ENGINEER, depending on the weather and the materials used.

3.26 Bituminous Concrete Curb

A. Bituminous concrete curb shall be constructed to the design specified on the Plans or as approved by ENGINEER and shall include the conditioning and treating of the surface on which the curb is to be placed.

- B. Materials used in the construction and installation of bituminous concrete curbing shall meet the requirements as specified in Part 2, Products of this Section, and as specified in MDOT, Section 904.
- C. Bituminous concrete curb mixture shall be 13 or 13A as specified in this Section and in accordance with MDOT, Section 501, unless otherwise approved by ENGINEER.
- D. Bituminous curb shall be constructed to conform to the Plans or as determined by ENGINEER. The method of construction shall conform to MDOT, Section 805, unless otherwise specified.
- E. Bituminous mixture shall be thoroughly compacted by a curbing machine to the cross section shown on the Plans, or as determined by ENGINEER. The curb shall be formed to the density to produce a tight surface texture. Curbs showing segregation, slumping, or misalignment shall be removed and replaced at CONTRACTOR's expense.
- F. When specified on the Plans or as directed by ENGINEER, an application of asphalt emulsion or other approved bituminous coating shall be applied to the finished curb at the joint of the curb and pavement, or to the inside face of the curb, or to both, as a protective seal.
- G. Backfilling behind the curb shall not commence until the bituminous mixture has cured.
- H. Backfill material shall be placed and thoroughly tamped and compacted to the satisfaction of ENGINEER, without disturbing the curb, and shall be left in a neat and workmanlike condition.

3.27 Bituminous Approaches, Sidewalks, and Shoulders

- A. This Work shall consist of constructing a bituminous surface course as specified on the Plans, or as approved by ENGINEER. Bituminous surface course shall be placed on a prepared foundation.
- B. Bituminous materials used shall be as specified on the Plans, or as approved by ENGINEER. Materials acceptable for use are specified in Part 2 of this Section, and as specified in MDOT, Section 904.
- C. Bituminous approach mixture shall be in accordance with MDOT, Section 501, unless otherwise approved by ENGINEER.
- D. Existing pavement or aggregate base shall be prepared to receive the bituminous surface course as specified in this Section.
- E. Bituminous prime and bond coats used shall meet the requirements specified in this Section. Care shall be taken to prevent spreading of bituminous material on adjoining surfaces. When approved by ENGINEER, the prime coat may be omitted.
- F. The bituminous mixture shall be placed to the thickness specified on the Plans or as determined by ENGINEER.
- G. Placing the bituminous mixture shall conform to this Section.

H. When approved by ENGINEER, the paver used for placing bituminous approaches and sidewalks will not be required to have an automatically controlled or activated screed or strike-off assembly or the corresponding grade referencing equipment. Also, with approval from ENGINEER, only one (1) roller may be used with each paver.

3.28 Tennis Courts

- A. Bituminous tennis courts shall be constructed to the cross section shown on the Plans, or as determined by ENGINEER.
- B. Materials used in the construction of the bituminous tennis court shall meet the requirements specified in Part 2 of this Section, and as specified in MDOT, Section 904.
- C. Bituminous base course mixture shall be 13 or 11A as specified in this Section and MDOT, Section 501 unless otherwise specified on the plans.
- D. Bituminous surface course mixture shall be 4C, 13A or 36A as specified in this Section and MDOT Section 502, unless otherwise specified on the plans.
- E. Asphalt content and performance grade shall be determined by the job mix formula submitted by the CONTRACTOR and approved by ENGINEER.
- F. Bituminous base course and wearing course shall be constructed to conform to the Plan. The method of construction shall conform to MDOT Section 502, unless otherwise specified.
- G. Bituminous bond coat used shall meet the requirements specified in this Section.
- H. The rate of application shall be 0.05 0.10 gallons per square yard (225 to 450 ml/m²).
- I. For the preparation of the foundation to receive the bituminous base course and bituminous surface course, see the appropriate Articles in Part 3 of this Section.
- J. Bituminous base course, if required, and the bituminous surface course shall be installed to thickness shown on the Plans. The method of installation of mixtures shall conform to this Section.

3.29 Cleanup

- A. Area adjacent to the new Work shall be backfilled with sound earth of topsoil quality.
- B. Backfill shall be compacted, leveled and left in a neat, workmanlike condition. At a seasonally correct time the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 32 9223, Sodding.

3.30 Monument Boxes

A. Government, plat, and street intersection monuments within existing or proposed pavement shall be preserved by enclosing in standard monument boxes. Monument box castings shall be furnished and installed by CONTRACTOR and shall be East Jordan Iron Works No. 1570, or approved equal.

B. Existing monument boxes shall be adjusted to meet the proposed pavement elevation by removing the castings and resetting to the required elevation. Support for the monument box shall be concrete bedding, so constructed as to hold them firmly in place. The adjacent pavement, curb, or curb and gutter shall be replaced to the new elevation, condition, and kind of construction, unless otherwise provided.

3.31 Testing

- A. During the course of the Work, ENGINEER may require testing for mix designs, aggregate gradation, and physical properties, bitumen content, compaction or density, and thickness of material. Testing and coring required shall be performed by a testing laboratory approved by ENGINEER. Cost for testing and coring shall be at the expense of OWNER. The testing laboratory shall furnish ENGINEER with two certified copies of the results of all tests.
- B. Testing procedures shall conform to current MDOT Standards for Construction.
- C. Testing of asphalt binders, liquid asphalts, asphalt emulsions, tars shall conform to MDOT, Section 904.
- D. Rolling shall proceed until the required compaction is attained and the amount of rolling required shall be based on the test results of a nuclear gage or on using a specified minimum number of rollers. When the total tonnage for the Project is in excess of 1,000 Tons (900 metric tons), the nuclear gage method will be used to govern the compactive requirements.
- E. Control density for the bituminous mixture to be placed, will be determined by use of a modified Marshall Test.
- F. Control Density:
 - 1. During CONTRACTOR's start-up operations, a rolling procedure to attain the control density will be established.
 - a. Rolling procedure will be based on the number and type of rollers used and the rolling pattern.
 - b. Goal of the compactive effort will be to establish a rolling procedure which will achieve 100% of the control density but in any case, the density achieved shall not be less than 95% of the control density.
 - c. Density values less than 98% will be sufficient cause for ENGINEER to require an adjustment in the number or type of rollers being used or in the rolling pattern.
 - 2. Once the procedure has been established on the start-up section, the procedure shall be used for the remainder of the mixture to be placed, unless subsequent tests indicate a need to change the number of rollers or the rolling pattern.
 - 3. If difficulties are encountered or if there is a significant change in aggregate or bitumen content, ENGINEER will determine the control density for the new mixture and require CONTRACTOR to again establish the number and type of rollers and the rolling pattern required on the new mixture to attain the control density. Compactive procedures thus determined shall be used when placing the remainder of that mixture.

- 4. Density checks will be made at the discretion of ENGINEER to determine if the compactive procedure being used is achieving the required density, or if a change in procedure is necessary.
- 5. Each layer of bituminous mixture shall be compacted to at least 95% of the control density, using the established procedure.

3.32 Price Adjustments

- A. Samples of asphalt binder may be taken prior to incorporation into the mixture and from the bituminous mixture. Where results of tests on these samples deviate from specification requirements, the affected material will be subject to price adjustments on the following basis:
 - 1. When the test results deviate from the limits specified in MDOT, Table 904-1, Performance Graded Asphalt Binder Specification, by ten (10) percent or more, the mixture produced will be evaluated by ENGINEER and if in his judgment the defective pavement warrants removal, CONTRACTOR shall remove and replace the affected area at his expense. If it is determined that the removal is not required, the Contract unit price of the affected mixture will be reduced by ten (10) percent.
 - 2. Core samples may be taken on the completed Work. If the results from testing of the core samples indicates a deficiency in the completed Work, ENGINEER will evaluate the test results and will recommend removal and replacement or a credit to OWNER.

See Next Page

| Table A: Composition of Mixtures | | | | | | | | | | |
|----------------------------------|--------|--------|--------|--------------|-------------|--------|-------|-------|--------|--------|
| Mixture No. | 2B | 2C | 3B | 3C | 4B | 4C | 13 | 13A | 11A | 36A |
| Binder % | 4-6 | 4-6 | 4.5-7 | 4.5-7 | 5-8 | 5-8 | 5-8 | 5-8 | 4-6 | 5.5-8 |
| | | | Per | cent Passing | g Indicated | Sieve | | | | |
| 1-1/2" (37.5 mm) | 100 | 100 | | | | | | | 100 | |
| 1" (25 mm) | 99-100 | 99-100 | 100 | 100 | | | | | 90-100 | |
| 3/4" (19 mm) | 90 max | 90 max | 99-100 | 99-100 | 100 | 100 | 100 | 100 | 70-95 | |
| 1/2" (12.5 mm) | 78 max | 78 max | 90 max | 90 max | 99-100 | 99-100 | 75-95 | 75-95 | 55-85 | 100 |
| 3/8" (9.5 mm) | 70 max | 70 max | 77 max | 77 max | 90 max | 90 max | 60-90 | 60-90 | 40-80 | 92-100 |
| No. 4 (4.75 mm) | 52 max | 52 max | 57 max | 57 max | 67 max | 67 max | 45-80 | 45-80 | 25-65 | 65-90 |
| No. 8 (2.36 mm) | 15-40 | 15-40 | 15-45 | 15-45 | 15-52 | 15-52 | 30-65 | 30-65 | 15-50 | 55-75 |
| No. 16 (1.18 mm) | 30 max | 30 max | 33 max | 33 max | 37 max | 37 max | 20-50 | 20-50 | 10-40 | |
| No. 30 (600 um) | 22 max | 22 max | 25 max | 25 max | 27 max | 27 max | 15-40 | 15-40 | 7-32 | 50-20 |
| No. 50 (300 um) | 17 max | 17 max | 19 max | 19 max | 20 max | 20 max | 10-25 | 10-25 | 5-20 | |
| No. 100 (150 um) | 15 max | 15 max | 15 max | 15 max | 15 max | 15 max | 5-15 | 5-15 | 4-12 | |
| No. 200 (75 um) | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-10 |
| Crushed Min. % | 50 | 90 | 50 | 90 | 50 | 90 | 0 | 25 | 25 | 60 |

| Table B: Mix Design Criteria | | | | | | | | | | |
|---------------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Mixture No. | 2B | 2C | 3B | 3C | 4B | 4C | 13 | 13A | 11A | 36A |
| VMA Min. % | 13.5 | 13.5 | 15 | 15 | 16 | 16 | 15.5 | 15.5 | 13.5 | 16.5 |
| Air Voids % Target (1) | 3 | 3 | 3.5 | 3.5 | 3.5 | 3.5 | 3 | 3 | 3 | 3 |
| Fines/Binder Ratio Max. (2) | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Fine Aggregate Angularity Min. (3) | 3 | 4 | 3 | 4 | 3 | 4 | 2 | 2.5 | 2.5 | 3 |
| Flow-in. (mm) | .0816 (2.0-4.0) |
| L.A. Abrasion Max. % loss (4) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 50 | 40 |
| Soft Particle Max. % (5) | 12 | 12 | 12 | 12 | 8 | 8 | 8 | 8 | 12 | 8 |
| Stability Min. Pounds (kN) | 1200 (5.3) | 1200 (5.3) | 1200 (5.3) | 1200 (5.3) | 1200 (5.3) | 1200 (5.3) | 900 (4.0) | 900 (4.0) | 900 (4.0) | 900 (4.0) |

Notes:

- (1) The JMF target may be adjusted in the field, prior to placement, to meet the project design criteria for a specific application; for example, 2.0 percent air voids on shoulders or bike paths.
- (2) Fines/Binder Ratio. The ratio of aggregate material finer than the No. 200 (75 um) sieve to asphalt binder content by weight including fines and bituminous contributed by reclaimed asphalt pavement (RAP).
- (3) The fine aggregate angularity of blended aggregate, determined by MTM 118, must meet the minimum requirement. In mixtures containing RAP, the required minimum fine aggregate angularity must be met by virgin material.
- (4) Los Angeles abrasion loss must be met for the composite mixture; however, each individual aggregate must be less than 50.
- (5) The sum of the shale, siltstone, structurally weak, and clay-ironstone particles shall not exceed 8.0 percent for aggregates used in top course. The sum of the shale, siltstone, structurally weak, and clay-ironstone shall not exceed 12 percent for base and leveling courses.

| Table C: Uniformity Tolerance Limits For Bituminous Mixtures | | | | | | | | |
|--|-----------|--------|--------------------------------------|------------------|------------------|-------------------|--|--|
| | | Percei | Percentage Passing Designated Sieves | | | | | |
| Type of Course | Range (a) | (b) | No. 8 2.35 mm | No. 30 600 um | No. 200 75 um | Binder Content | | |
| Tap and Loveling Course | Range 1 | ± 5.0 | ± 5.0 | ± 4.0 | ± 1.0 | ± 0.40 | | |
| Top and Levening Course | Range 2 | ± 8.0 | ± 8.0 | ± 6.0 | ± 2.0 | ± 0.50 | | |
| Pasa Courses | Range 1 | ± 7.0 | ± 7.0 | ± 6.0 | ± 2.0 | ± 0.40 | | |
| Dase Courses | Range 2 | ± 9.0 | ± 9.0 | ± 9.0 | ± 3.0 | ± 0.50 | | |

Notes:

This range allows for normal mixture and testing variations. The mixture shall be proportioned to test as closely as possible to the Job Mix Formula.
This includes all sieve sizes No. 4 (4.75 mm) and larger listed on the Job Mix Formula.

| Table A ¹ : Composition of Mixtures | | | | | | | | | |
|--|--|---|----------------------------|--------------------|-------------------|-------------------|------------------|------------------|-----------------------------|
| Total Percent Passing Indicated Sieve (a) | | | | | | | | | |
| Mixture No. | No. 1800 No. 1500 No. 1300 (36A)(36B) | No. 1800 No. 1500 No. 1300 (20AAA) | No. 1100 (36A) (36B) | NO. 1100 (20AA) | NO. 1100 (20A) | No. 900 (20AA) | No. 900 (20A) | No. 900 (20B) | No. 700 No. 500 (20C) |
| 1-1/2" (37.5 mm) | - | - | - | - | - | - | - | - | 100 |
| 1" (25 mm) | - | - | - | - | - | - | - | - | 80-100 |
| 3/4" (19 mm) | - | 100 | - | 100 | 100 | 100 | 100 | 100 | - |
| 1/2" (12.5 mm) | 100 | 90- 00 | 100 | 90-100 | - | 90-100 | - | - | - |
| 3/8" (9.5 mm) | 92-100 | 65- 5 | 92-100 | 65-95 | 60-90 | 65-95 | 60-90 | 60-95 | 55-90 |
| No. 4 (4.75 mm) | 65-90 | 55- 5 | 65-90 | - | - | - | - | - | - |
| No. 8 (2.36 mm) | 55-75 | 45- 0 | 55-75 | 45-70 | 40-65 | 45-70 | 40-65 | 40-70 | 30-55 |
| No. 30 (600 um) | 25-50 | 20- 5 | 25-50 | 20-45 | 20-40 | 20-45 | 20-40 | 20-45 | 15-40 |
| No. 200 (75 um)(b) | 4 -10 | 3-0 | 4-10 | 3-10 | 3-10 | 3-10 | 3-10 | 3-10 | 3-10 |
| Binder % (c) | 5-9 | 5-9 | 5-9 | 5-7 | 5-7 | 5-7 | 5-8 | 5-8 | 3-6 |
| Crushed Min. % | (d) | 60 | (d) | 40 | 25 | 40 | 25 | - | - |

Notes:

(a) Composition limits are shown in percent by weight, based on the total aggregate, including mineral filler in the mixture.

(b) The Job-Mix-Formula shall have a minimum total percent passing a No. 200 sieve of 5.0 percent.

(c) The percent of bitumen in the mixture shown in Table A1 is a range and the actual bitumen content in the production mixture shall be as determined by the Job-Mix-Formula. For mixtures No. 900, 1100, 1300, 1500, and 1800 placed in two courses, the leveling course will be designed to have up to 0.5 percent less bitumen than the optimum specified for the top course. Mixtures No. 500 and 700 will be designed to have a target air void of 4.0 percent.

(d) 36A = 60%, 36B = 40%

| Table B1: Mix Design Criteria | | | | | | | | |
|-------------------------------|---------------------|-------------------------------|--------------------|--------------------|-----------------------|--|--|--|
| Mixture No. | Aggregate Required | Stability Pounds (Minimum) | Flow (.00 inch) | VMA % (Minimum) | Air Voids % Target | | | |
| 500 | 20jC | 500 | - | 13.0 | 4.0 | | | |
| 700 | 20C | 700 | 8-16 | 13.0 | 4.0 | | | |
| 900 | 20B, 20A, 20AA | 900 | 8-16 | 13.5 | 2.5 | | | |
| 1100 | 20A, 20AA, 36A, 36B | 1100 | 8-16 | 13.5 | 3.0 | | | |
| 1300 | 20AAA, 36A, 36B | 1300 | 8-16 | 14.0 | 3.0 | | | |
| 1500 | 20AAA, 36A, 36B | 1500 | 8-16 | 14.0 | 3.0 | | | |
| 1800 | 20AAA, 36A, 36B | 1800 | 9-16 | 14.0 | 3.0 | | | |

End of Section

Section 32 1315 Sidewalks and Driveways

Part 1 General

1.01 Scope of Work

A. This Section includes sidewalks, sidewalk ramps, driveways, and drive approaches complete with concrete materials, concrete curing compounds, joint materials, field quality control and appurtenances.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 31 1100: Clearing and Grubbing
- C. Section 31 2313: Subgrade Preparation
- D. Section 32 9219: Seeding
- E. Section 32 9223: Sodding

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 American Society of Testing and Materials
 - 2. AASHTO American Association of State Highway and Transportation Officials
 - 3. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.04 Submittals

- A. Written permission for the use of all local disposal sites shall be obtained and copies shall be furnished to ENGINEER.
- B. At the request of ENGINEER, CONTRACTOR shall provide ENGINEER with certification that the various materials to be used conform to the ASTM Standards referred to in the Specification.

1.05 Test Reports

A. ENGINEER shall be provided with two (2) certified copies of the test results of the thickness and compressive strength of the concrete. Core drilling, testing for thickness and compressive strength and the certification of the test results shall be performed by a testing laboratory approved by ENGINEER.

1.06 Environmental Requirements

A. Comply with the requirements for concrete installation due to outside ambient air temperatures specified under Article 3.11 of this Section.

1.07 Protection

- A. Comply with the requirements for protecting new Work against damage from rain, as specified under Article 3.11 of this Section.
- B. Comply with the requirements for protecting new Work against damage from cold weather, as specified under Article 3.11 of this Section.

Part 2 Products

2.01 Concrete

A. Concrete shall be in accordance with MDOT Section 601 or 701, use Grade P1 or S2, 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (335 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 6.5% ± 1.5% air content; 3-inch (75 mm) maximum slump; no admixtures without ENGINEER's approval. Type IIIA cement may be used for high-early strength concrete.

2.02 Ready-Mixed Concrete

A. Ready-mixed concrete shall conform to ASTM C94, Alternate 2.

2.03 Water

A. Water to be used for mixing and curing concrete shall be reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Waters from sources approved by the Michigan State Department of Public Health as potable may be used without test. Water requiring testing shall be tested in accordance with the current Method of Test for Quality of Water to be Used in Concrete, AASHTO T26, and as specified in MDOT Section 911.

2.04 Concrete Curing Compounds

A. White membrane curing compound for curing concrete shall conform to ASTM C309, Type 2, Class B Vehicle, and as specified in MDOT, Section 903.

2.05 Premolded Joint Filler

A. Fiber joint filler for expansion joints shall conform to ASTM D1751. Filler shall be of the thickness, as specified herein, or on the Plans, or as approved by NGINEER.

2.06 Steel Hook Bolts

A. Hook bolts shall conform to ASTM A706, or Grade 60 of ASTM A615, A616-96a, or A617-96a. Hook bolts shall be 5/8 inch (16 mm) diameter.

2.07 Joint Sealant

A. Hot-poured type joint sealant shall conform to ASTM D6690 Type II and as specified in MDOT Section 914.

2.08 Concrete Mix

A. Concrete shall contain a minimum of six sacks, 94 pounds per sack, of cement per cubic yard (335 kg/m³) and shall yield a minimum compressive strength of 3,500 psi (24 MPa) at 28 days.

- B. Cement shall be air-entraining Portland cement ASTM C150, Type 1A. If high-early strength concrete is desired, Type IIIA is required.
- C. High-early concrete can be obtained for small areas by the addition of one sack of cement, Type 1A, per cubic yard of concrete (56 kg/m³).
- D. The air content of the concrete shall be $6.5\% \pm 1.5\%$ by volume.
- E. Maximum slump of the concrete shall be three (3) inches (75 mm).
- F. Ready-mixed concrete in accordance with ASTM C94, Alternate 2, shall be used, unless a written request for other than ready-mixed concrete has been submitted, reviewed and approved by ENGINEER.

Part 3 Execution

3.01 Verification of Excavation and Forming

- A. Prior to the installation of any concrete, examine the excavation and forms for the proper grades, lines, and levels required to receive the new Work. Ascertain that excavation and compacted subgrades are adequate to receive the concrete to be installed.
- B. Correct all defects and deficiencies before proceeding with the Work.

3.02 Existing Improvements

- A. Investigate and verify location of existing improvements to which the new Work is to be connected.
- B. Adjustments in line and grade to align the new Work with the existing improvements must be approved by ENGINEER, prior to any change.

3.03 Forming

- A. Forms shall be of wood or metal, straight and free from warp, clean, and of sufficient strength to resist springing during the process of depositing concrete against them.
- B. Forms shall be the full depth of the concrete.

3.04 Sidewalks, Sidewalk Ramps, Driveways, and Driveway Approaches

- A. Unless otherwise noted in the Contract Documents, all sidewalks and sidewalk ramps shall be four (4) inches (100 mm) thick except at driveways, where the thickness of the sidewalks shall be six (6) inches (150 mm).
- B. Sidewalks shall be five (5) feet (1.5 m) wide unless otherwise noted on Plans, and shall slope 1/4 inch per foot (20 mm/m) towards the surface drainage side which in general will be towards the center of the road.
- C. Normally sidewalks will be located within the right-of-way, parallel the property lines, at a distance of 1-foot (300 mm) from the property line.
- D. Driveways and approaches shall be six (6) inches (150 mm) thick. The width of driveways and driveway approaches shall be as specified on the Plans or as determined by ENGINEER.

3.05 Remove Curb for Curb Drop

- A. Construction of sidewalk ramps within street intersections where curbed pavement exists shall conform to the current rules and regulations of Act 8, Michigan PA 1973.
- B. Where there is no proper curb drop for the sidewalk ramp or driveway approach, CONTRACTOR shall saw cut, to full depth of pavement, and remove a minimum of an 18inch (450 mm) wide curb and gutter section. When mountable curbs are present, CONTRACTOR shall remove a 24-inch (600 mm) wide curb and gutter section for the construction of sidewalk ramp, as specified above.
- C. Length of curb and gutter removal shall be determined by ENGINEER in the field but shall be at least as wide as the proposed sidewalk ramp plus 1-foot (300 mm) on each side.
- D. Removed curb and gutter section shall be replaced with material, equal to what was removed and the joint sealed with hot poured rubber asphalt.
- E. CONTRACTOR shall install 5/8 inch (15 mm) diameter self tapping hook bolts, in the existing concrete pavement as indicated on the Plans prior to placing concrete for the removed curb and gutter section.
- F. Curbs may be cut or ground down with an approved concrete grinder when the final results will leave the cut or ground down curb in a smooth, clean condition acceptable to ENGINEER. Curbs that are cut or ground down that are not acceptable to ENGINEER, shall be removed and replaced as specified above at no additional cost.

3.06 Placement of Forms

- A. Wood forms, straight and free from warp, of nominal depth may be used for sidewalk sections less than 25 feet (7.5 m) in length.
- B. Forms shall be staked to line and grade in a manner that will prevent deflection and settlement.
- C. When unit slab areas are to be poured, slab division forms shall be so placed that the slab division joints will be straight and continuous.
- D. Forms shall be set for sidewalk ramps to provide a grade toward the centerline of the right-of-way in accordance with current standards. The grade shall be uniform, except as may be necessary to eliminate short grade changes.
- E. Forms shall be oiled before placing concrete. Forms shall remain in place at least 12 hours after the concrete is placed. There shall be sufficient forms placed ahead of the pouring operations to maintain uninterrupted placement of concrete.
- F. The use of slip form pavers can be allowed when approved by ENGINEER in lieu of the construction system described above.

3.07 Joints

A. Transverse and longitudinal expansion and plane-of- weakness joints shall be constructed at the locations specified herein, or as indicated on the Plans or as approved by ENGINEER.

- B. Transverse expansion joints shall be placed for the full width and depth of the new Work. The transverse expansion joints placed against any existing pavement shall be a minimum of 6 inches (150 mm) deep but no less than the thickness of the concrete being placed.
- C. Longitudinal expansion joints shall conform to the same requirements as transverse expansion joints.
- D. Joints shall be constructed true to line with their faces perpendicular to the surface of the sidewalk. The top shall be slightly below the finished surface of the sidewalk. Transverse joints shall be constructed at right angles to the centerline of the sidewalk and longitudinal joints shall be constructed parallel to the centerline or as determined by ENGINEER.
- E. Unless otherwise specified on the Plans or unless otherwise determined by ENGINEER, when the sidewalk is constructed in partial width slabs, transverse joints in the succeeding slabs shall be placed in line with like joints in the adjacent slab. Also, in the case of widening existing sidewalks, transverse joints shall be placed in line with like joint in the existing sidewalk.
- F. Transverse expansion joints, 1/2 inch (10 mm) thick, shall be placed through the sidewalk at uniform intervals of not more than 50 feet (15 m) and elsewhere as shown on the Plans, or as determined by ENGINEER.
- G. Expansion joints, 1/2 inch (10 mm) thick, shall also be placed between the sidewalk and back of abutting parallel curb, buildings or other rigid structures, concrete driveways and driveway approaches. The expansion joint between sidewalks and buildings shall be placed 1-foot from the property line and parallel to it.
- H. Expansion joints, 1-inch (25 mm) thick, shall be placed between sidewalk ramps or driveway approaches and the back of curbs.
- I. Plane-of-weakness joints shall be formed every 5 feet (1.5 m) and shall be produced by use of slab divisions forms extending to the full depth of the concrete or by cutting joints in the concrete, after floating, to a depth equal to 1/4 the thickness of the sidewalk. Cut joints shall not be less than 1/8 inch (3 mm) nor more than 1/4 inch (5 mm) in width and shall be finished smooth and shall be at right angles to the centerline of the sidewalk.

3.08 Placing and Finishing Concrete

- A. Concrete shall be placed on a prepared unfrozen, smooth, leveled, rolled and properly compacted base as indicated on the Plans. The surface of the subbase shall be moist with no visible water present prior to placement of the concrete.
- B. Concrete shall be deposited, in a single layer, to the depth specified in the Plans or in the Proposal. Concrete shall be thoroughly spaded or vibrated and compacted to fill in all the voids along the forms and joints. Concrete shall be struck off with a strike board until all voids are removed and the surface has the required grade and cross section as indicated on the Plans.
- C. The surface of the concrete shall be floated just enough to produce a smooth surface free from irregularities. All edges and joints shall be rounded with an edger having a 1/4 inch (5 mm) radius. The surface of sidewalks, driveways and approaches shall be broomed to slightly roughen the surface.

D. The surface of sidewalk ramps shall be textured with a coarse broom transversely to the ramp slope. The texture on sidewalk ramps shall be coarser than the remainder of the sidewalk.

3.09 Curing

- A. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the concrete (and sides if slip-forming is used) shall be completely coated and sealed with a uniform layer of white membrane curing compound.
- B. The curing compound shall not be thinned. The curing compound shall be applied at the rate of 1-gallon per 200 square feet (4 L per 20 m²) of surface.

3.10 Barricades

- A. Suitable barricades and lights shall be placed around all newly poured sidewalks, sidewalk ramps, driveways, driveway approaches and curb and gutter section in order to protect the new Work from damage from pedestrians, vehicles and others until the concrete has hardened.
- B. Barricades shall be left in place for a minimum of two (2) days, except for driveway approaches and curb and gutter section. Barricades shall remain in place for a minimum of three (3) days.
- C. Concrete that suffers surface or structural damage shall be removed and replaced by CONTRACTOR at his expense.

3.11 Protection

- A. CONTRACTOR shall adequately protect the new concrete from the effects of rain before the concrete has sufficiently hardened. For this Work CONTRACTOR shall have available on the job site at all times enough burlap or 6-mil thick polyethylene film to cover and protect one (1) day's work. When rain appears eminent, operations shall stop and personnel shall begin covering. As soon as the rain ceases, the concrete shall be uncovered, and the surface burlap dragged where necessary. Curing compound shall be applied to any areas where the compound has been disturbed or washed away.
- B. If concrete is placed between October 15 and May 15, CONTRACTOR shall have available on the site sufficient amount of clean, dry straw or hay to cover one day's production. If the temperature reaches 40 degrees Fahrenheit (4 degrees Celsius) and is falling, the hay or straw shall be placed 12 inches (305 mm) thick, immediately after the curing compound is applied. If the temperature is 30 degrees Fahrenheit (-1 degrees Celsius) and falling the curing shall be by 6-mil thick polyurethane film placed on the concrete as soon as the surface moisture has disappeared, and then covered with 12 inches (300 mm) of straw or hay.
- C. Also, whenever the temperature in the shade falls below 50 degrees Fahrenheit (10 degrees Celsius), the water, sand and coarse aggregate shall be heated in that order sufficiently to maintain a uniform temperature of the concrete at between 70 degrees Fahrenheit and 80 degrees Fahrenheit (21 to 27 degrees Celsius).
- D. Concrete shall not be placed when the temperature of the concrete at the point of placement is above 90 degrees Fahrenheit (32 degrees Celsius).

3.12 Cleanup

- A. After the concrete has gained sufficient strength, but no sooner than within 12 hours, the fixed forms shall be removed and the spaces on both sides shall be immediately backfilled with sound earth of topsoil quality. Backfill shall be compacted, leveled and left in a neat, workmanlike condition.
- B. At a seasonally correct time approved by ENGINEER, the disturbed area shall be raked, have topsoil placed thereon, fertilized and seeded per the requirements of Section 32 9219, Seeding, or sodded in accordance with Section 32 9223, Sodding.

3.13 Testing

- A. ENGINEER may require that a minimum of two cores be drilled from the sidewalk for each 500 (or fraction thereof) linear foot (150 m) section placed. At least one (1) core out of two (2) required will be taken from the sidewalk at the driveway. One (1) core may be required from every 20 (or fraction thereof) of driveway approaches or sidewalk ramps installed.
- B. Cores shall be checked for depth and compressive strength. Core drilling and tests shall be done by a testing laboratory designated by OWNER and at the expense of OWNER. The testing laboratory shall furnish ENGINEER with two (2) certified copies of the test results.
- C. In the event the test results on a core indicates a deficiency in either thickness or compressive strength the following adjustments in the unit price for concrete shall be made:

| Thickness | | | | | | |
|---|------------------------------------|--|--|--|--|--|
| Under Required Thickness | Percent of Reduction in Unit Price | | | | | |
| 0" to 1/4" | None | | | | | |
| by more than a 1/4", but not exceeding a 1/2" | 20 | | | | | |
| by more than a 1/2", but not exceeding 1" | 50 | | | | | |
| by more than 1" | Remove & Replace | | | | | |

| Compressive Strength | | | | | | |
|---|------------------------------------|--|--|--|--|--|
| Under Required Compressive Strength | Percent of Reduction in Unit Price | | | | | |
| 0 to 150 psi | None | | | | | |
| by more than 150 psi, but not exceeding 300 psi | 20 | | | | | |
| by more than 300 psi, but not exceeding 500 psi | 50 | | | | | |
| by more than 500 psi | Remove & Replace | | | | | |

D. The area of the deficient core shall be determined by the drilling and testing of two (2) additional cores, one (1) on each side of the deficient core and 20 feet (6 m) from it when possible. Extra core drilling and testing shall be at the expense of CONTRACTOR. Reductions due to deficiencies in thickness or compressive strength are additive, that is, if an area is deficient by 3/8 inch (9 mm) and under strength by 200 psi (1.3 MPa), the total reduction is 20% plus 20% or 40% reduction.

End of Section

Section 32 9219 Seeding

Part 1 General

1.01 Scope of Work

A. This Section includes seeding complete with earth bed preparation, providing and placing topsoil, preparation and fertilizing topsoil, sowing of seed for lawns and other ground cover, protection of seeded areas, watering of seeded areas, mowing of seeded areas, protection and cleanup.

1.02 Related Work Specified Elsewhere

- A. Section 01 8900: Site Construction Preparation Requirements
- B. Section 31 2200: Grading

1.03 Requirements of Regulatory Agencies

- A. Comply with the applicable requirements of the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division, Michigan Seed Law, Act 329, PA of 1965, as amended.
- B. Comply with the applicable requirements of the Proceedings of the Association of Official Seed Analysts, Rules for Testing Seeds.
- C. Chemical fertilizer shall be supplied in suitable bags with the net weight of the contents and guaranteed analysis shown on the container. Bulk shipments shall be accompanied by an analysis and net weight certification of the shipment. Custom mixed fertilizers shall be accompanied by a certification of the weight of each commercial fertilizer used in the mixture and a guaranteed analysis of each shipment expressed in percentages of total Nitrogen (N), total available Phosphoric Acid (P₂O₅) and total available Potash (K₂O) included.

1.04 Source Quality Control

A. A seed mixture proposed for use in the Work shall have been tested for purity and germination by the Seed Producer within nine (9) months of sowing.

1.05 Reference Standards

- A. ASTM American Society for Testing and Materials
- B. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest edition

1.06 Submittals

- A. Submit Seed Producers Certification that seed meets the requirements of these Specifications and conform to the State of Michigan Seed Act referenced above under Article 1.03 of this Section.
- B. Where required, submit test reports for all seed proposed for use in the Work to ENGINEER, showing results of purity and germination tests, compliance with regulatory agencies, dates and location of tests.

1.07 Product Delivery, Storage, and Handling

- A. Material shall be delivered to the Project site in their original, unopened containers. Containers shall be clearly marked showing, name of manufacturer, brand name, trade name or generic name of material, warranty of analysis, net weight of contents and date of packaging, where applicable.
- B. Seed shall be delivered to the site in durable bags, tagged or labeled to show date of tests, warranty of purity and germination analysis, name, lot number and net weight of contents.
- C. Commercial fertilizers shall be delivered to the site of the Work in the original unopened bags. Bags shall not exceed 100 pounds (45 kg) net weight each and shall be clearly marked with guaranteed analysis in a conspicuous location on each bag.
- D. Material shall be stored at the Project site, under shelter, off the ground and shall be protected from damage by moisture, temperature, exposure to elements, vandalism or other action which might otherwise impair their use.
- E. Materials proposed for use in the Work shall be handled in a manner that will protect the material and the personnel involved in the Work. Handle seed in a manner which will protect the mixture from contamination or deterioration.

1.08 Environmental Requirements

- A. Seeding is limited to the periods between April 20 and June 1, August 10 to October 1 and after November 20 for as long as weather permits preparation of the seed bed without irrigation and/or mulch. With the use of irrigation and/or mulch, seeding can be done from April 20 thru October 1 inclusively.
- B. Comply with the limitations placed on the use of certain soil protection materials because of prevailing temperatures as described in this Section.
- C. Comply with the limitation placed on seeding applications because of wind velocity as described-in this Section.

1.09 Protection

- A. Provide suitably approved warning signs and barricades for protection of seeded areas from pedestrian or vehicular traffic. Protect all newly seeded areas during the progress of the Work and until completion of the turf establishment period.
- B. Protect all adjacent construction from topsoil spills and perform such cleanup of affected surfaces before it becomes compacted by traffic.

1.10 Final Acceptance

- A. CONTRACTOR shall establish a dense cover of seeded grass on disturbed areas.
- B. These areas shall be maintained until final acceptance of the Work by ENGINEER.
- C. ENGINEER will inspect the turf to insure that the grass seed is well established, weed free, in a growing and vigorous condition.
- D. Areas that do not meet the approval of ENGINEER shall be re-seeded at CONTRACTOR's expense.

Part 2 Products

2.01 Seed

A. Seed and seeding mixtures shall be certified, mature, clean, dry, new crop seed products suitable for the specified applications and having the percentages of purity, germination and proportions, by weight, indicated in Table 1.

| Table 1 - Seeding Mixtures | | | | | | | | |
|----------------------------|--------|-------------|-----|-----|-----|-----|--|--|
| | S | eeds | I |) | | | | |
| Kind | Purity | Germination | TDS | TUF | TGM | THM | | |
| Kentucky Blue Grass | 98% | 80% | 5 | 10 | 10 | 30 | | |
| Perennial Rye Grass | 96% | 85% | 25 | 20 | 20 | 20 | | |
| Hard Fescue | 97% | 85% | 25 | 20 | 30 | | | |
| Creeping Red Fescue | 97% | 85% | 45 | 40 | 40 | 50 | | |
| Fults Salt Grass | 98% | 85%* | | 10 | | | | |

| Table 2 – Soil Types and Location of Seeding | | | | | | | | |
|--|------------------------|-------------------------|-----------------------------------|--|--|--|--|--|
| Symbol for Turf Seed Mixture | Soil Type | General Location | Rate of Seeding Ibs/ac (kg/ha) | | | | | |
| TDS | Dry Sandy to Sand Loam | Rural or Urban | 250 (280) | | | | | |
| TUF | All Types | Freeway, Blvds, Streets | 250 (280) | | | | | |
| TGM | Medium to Heavy | All | 250 (280) | | | | | |
| THM | Loamy to Heavy | Home and Business Turf | 250 (280) | | | | | |

- B. The specific mixture to be used shall be for the type of soil on the Project and the location of the seeding unless otherwise indicated on the Plans or as designated by ENGINEER.
- C. Hydroseeding shall consist of a blend of seed, fertilizer and hydromulch.

2.02 Mulching Material

- A. Straw: Small grain straw or grass or marsh hay acceptable to ENGINEER.
- B. Wood Excelsior:
 - 1. Green wood fibers, baled or blanket of type; manufacture acceptable to ENGINEER.
 - 2. Wood excelsior shall be made of green timber fiber baled so that the bales weigh 80 to 90 pounds at the time of manufacture.
 - 3. Wood excelsior blankets shall be made of a uniform web of interlocking fibers with a backing of fabric netting on one (1) side only. The fabric net shall have a mesh size not exceeding $1-1/2" \times 3"$ (40 mm x 75 mm) and shall be a woven of either cotton cord, twisted paper cord or a synthetic, biodegradable fiber. Blankets shall be produced in the form of a tightly compressed roll 36 inches ± 1-inch (900m m ± 25 mm) wide and approximately 120 feet (36 m) long. Blanket shall have a fiber net on the outside of the fiber mat. Blanket roll weight, when manufactured, shall average 85 pounds (38 kg) ± 10%. Each roll shall have separator sheets of 40 pound Kraft paper placed at the beginning and at the end of each roll to facilitate unrolling and handling at the job site. The Kraft paper sheet at the end of each roll shall also form a wrapper for the roll.

- C. Netting:
 - 1. Twisted Kraft paper or synthetic fiber, biodegradable woven mesh net material suitable for the application and acceptable to ENGINEER.
 - 2. The net shall consist of a biodegradable mesh with openings not to exceed 1-1/2" x 3" (40 x 75 mm)
 - 3. The net shall be furnished in widths of not less than 35 inches (900 mm).
- D. Proprietary Mulch Material:
 - 1. Biodegradable natural and/or synthetic materials suitably fabricated and acceptable to ENGINEER.

2.03 Mulch Anchoring Material

- A. Emulsified Asphalt:
 - 1. ASTM D977, Rapid Setting (R.S. 1 or 2), Medium Setting (M.S. 2 or 2h) or Slow Setting (S.S. 1).
- B. Mulch Anchoring Tool:
 - 1. Suitable unit having a series of flat, notched discs for punching and anchoring mulch in soil, or a regular farm disc weighted and set nearly straight as a substitute.
- C. Latex Base Adhesive:
 - 1. Latex base adhesive mixed with water at a ratio of 25 gallon of water to 1 gallon adhesive with 25 pounds of recycled newsprint as a tracer (14 L of adhesive with 0.35 kL of water with 28 kg of newsprint).
- D. Recycled Newsprint:
 - 1. Mix 7 pounds of newsprint with 7 gallons of water (60 kg of newsprint with 1000 L of water).
- E. Guar Gum:
 - 1. Mix 1 pound of dry adhesive with 26.5 gallons of water with 5 pounds of recycled newsprint as a tracer (55 kg adhesive / 12 200 L water / 280 kg newsprint).

2.04 Fertilizer

A. Fertilizer shall be a standard commercial grade fertilizer, conforming to state regulations, of the type recommended for grasses. The fertilizer shall contain slow release nitrogen amounting to 75% of the nitrogen available. Fertilizer shall be uniform in composition, free flowing and suitable for application with method selected. Fertilizer for hydraulic seeding shall be soluble or ground to a fineness that will permit complete suspension of all insoluble particles in the slurry.

2.05 Agricultural Liming Materials

A. Burnt lime (quick lime), hydrated lime, limestone (calcite and dolomite), marble shells and by-products shall conform to the requirements of ASTM C602.

2.06 Water

A. Free of matter harmful to plant growth.

2.07 Staples

A. Wire staples for holding mulching materials in place shall be not less than six (6) inches (150 mm) long No. 11 (U.S. Steel Gage) steel wire or longer.

2.08 Topsoil

A. Topsoil shall be fertile, friable, sandy clay loam without admixture of subsoil. Topsoil is to be free of glass, stones greater than one (1) inch (25 mm) in any dimension, weeds, undesirable grasses and other extraneous materials. Topsoil shall have the following range of values:

| 1. | Soil pH | 5.0 to 7.5 |
|----|-----------------------|-------------|
| 2. | Soluble Salts | 500 ppm max |
| 3. | Organic Content | 5 to 30 % |
| 4. | Silt Content | 35% to 50% |
| 5. | Clay Content | |
| 6. | Deleterious Material* | 5% max |

*rock, gravel, stone, sticks, roots, sod, etc.

- B. Compost may be mixed with topsoil to obtain the desired content. Topsoil is to be final screened thru a 5/8-inch (15 mm) maximum mesh screen prior to delivery to the Project site. ENGINEER shall review source and final screen results prior to release of topsoil. CONTRACTOR shall submit a certified analysis of the topsoil from each source to ENGINEER. Topsoil shall be placed in 3-inch (75 mm) minimum thickness throughout, or as specified in the plans or Specifications.
- C. CONTRACTOR shall obtain his own topsoil borrow pit source and shall obtain all necessary permits and agreements for the use of such borrow pits at his own expense.

2.09 Improved Topsoil

- A. Improved topsoil shall consist of a mixture of 2/3 topsoil and 1/3 compost. Compost shall be mature/stabilized, humus-like material derived from the aerobic decomposition of yard waste (i.e., grass clippings and leaves) or other materials as designated compostable as defined in P.A. 641 as amended and shall be in compliance with all federal and state law.
- B. The improved topsoil mixture shall have a dark brown or black color, be capable of supporting plant growth without ongoing addition of fertilizers or other soil amendments and shall not have objectionable odor. The mixture shall be free of glass, plastic, metal, and other contaminants, as well as viable weed seeds and other plant parts capable of reproducing. The mixture shall be such that no visible water or dust is produced when handling it.

- C. The manufacturer of the compost shall maintain annually on file with the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division, test data and a statement to show that the following criteria are being met by the compost provided for the project.
- D. The composition of the compost shall be within the following range of values:

| 1. | Quality Parameter | Range of Value |
|-----|------------------------|------------------------------|
| 2. | Soil pH | 6 to 7.5 |
| 3. | Soluble Salts | 2 to 5 mmho/cm |
| 4. | Carbon/Nitrogen Ratio | 13 to 20 parts C to 1 part N |
| 5. | Inerts | < 1% |
| 6. | Organic Matter | |
| 7. | Nitrogen | 1 to 2 % |
| 8. | Phosphorus | 0.2 to 0.8 % |
| 9. | Potassium | 0.5 to 1.5 % |
| 10. | Unit Weight | 535 to 775 Kg/m3 |
| 11. | Moisture Content | 40 to 50 % |
| 12. | Particle Size | < 20 mm maximum |
| 13. | Water Holding Capacity | > 100% |
| 14. | Heavy Metals | None |

- E. Maturity/Stabilization: An acceptable test that can demonstrate Maturity/Stability.
- F. Temperature: The compost material must have undergone the procedure to significantly reduce the pathogen level as referenced in EPA 40 CFR, Part 257 Regulations, Federal Register Vol. 58, No. 32, dated 2/19/93; Rules and Regulations. The temperature must be maintained at 40° C for 5 days with a temperature exceeding 55° C for at least 4 hours.
- G. Pathogens and Trace Elements: Shall meet the requirements of EPA 40 CFR; Part 503 Regulations, Federal Register Vol. 58, No. 32, dated 2/19/93; Rules and Regulations.
- H. To comply with the annual filing requirements with the Michigan Department of Agriculture, Pesticide and Plant Management Division, the supplier of the compost shall certify that the compost meets Michigan P.A. 641 as amended and EPA 40 CFR, Part 257 and 503 Regulations, Federal Register Vol. 58, No. 32; dated 2/19/93; Rules and Regulations.
- I. A data sheet shall accompany the certification.
- J. The data sheet shall show the following:
 - 1. Standard compost total nutrient test results, including N, P, K, Ca, Mg, Mn, Cu, Fe total carbon, pH, as provided by an acceptable testing laboratory
 - 2. Organic content
 - 3. Inert contamination
 - 4. Soluble salts
 - 5. Carbon/Nitrogen ratio
 - 6. Proof of maturity/stability acceptable to the Michigan Department of Agriculture

K. The certification and data sheets shall be mailed annually to the Michigan Department of Agriculture, Agriculture Environment Coordinator. The date shall be included on which the compost test results were mailed to the Michigan Department of Agriculture.

Part 3 Execution

3.01 Preparation of Subgrade

A. Complete all fine grading within the areas to be covered with topsoil necessary to bring the surface of the proposed subgrade to the elevations indicated on the Plans and parallel to the proposed finished grade. The surface of the subgrade immediately prior to being covered with topsoil shall be raked or otherwise loosened to a minimum depth of two (2) inches (50 mm) to facilitate making a bond between the subsoil and the topsoil.

3.02 Preparation of Soil

A. After the areas to be seeded have been brought to the required grade and properly trimmed and cleaned up, the existing soil shall be brought to a friable condition by harrowing or otherwise loosening and mixing to a depth of at least four (4) inches (100 mm). Lumps and clods shall be thoroughly broken. When the area to be seeded has been prepared and covered with a layer of topsoil as specified under Article 3.01 of this section, this operation will not be required.

3.03 Preparation of Mulch Material

A. When seed is to be sown through mulch which has been in place for a period of more than two (2) weeks or which is being held in place by a surface-applied coating of asphalt emulsion or other adhesive, the mulched area shall be prepared for seeding by discing, a spike-toothed harrow, or by other means acceptable to ENGINEER.

3.04 Placing and Spreading Topsoil

- A. Topsoil shall be placed and spread over the area designated on the Plans, or as determined by ENGINEER, to a depth of four (4) inches, ± 1-inch (100 mm ± 25 mm) or to such depth as specified on the plans.
- B. In all cases, topsoil shall be placed to a depth sufficiently greater than that shown on the Plans or specified so that, after natural settlement or rolling, the completed Work will conform to the lines, grades and elevations shown on the Plans.
- C. Spreading of topsoil shall be completed in such a manner that seeding as specified can proceed without additional moving of topsoil. Topsoil furnished and placed shall be considered incidental to seeding unless otherwise specified in the Proposal.
- D. After topsoil is spread, all large earth lumps, rocks, roots, debris, or other foreign matter shall be raked and removed from the topsoiled area and legally disposed of by CONTRACTOR.

3.05 Fertilizing

A. Chemical fertilizer shall be applied on the prepared soil surfaces at a minimum rate of 1/3 ton per acre (666 lbs/ac.) (750 kg/ha) of 12-12-12 fertilizer, or such other rate of another fertilizer mixture that yield 240 lbs/acre (270 kg/ha) of nutrient. Dry fertilizers shall be thoroughly disced, harrowed or raked into the soil to a minimum depth of not less than 1-inch (25 mm). Where hydraulic seeders are used for sowing seed, one half the

recommended rate of fertilizer may be spread in combination with such sowing with the balance incorporated into the soil prior to seeding. In all other cases, fertilizer shall be incorporated into the soil before any seeding is started.

3.06 Seeding

- A. Seed of the kind required shall be sown at the rate as specified in Table 2. Seed shall be sown in the presence of an inspector by mechanical spreader, hydraulic seeder or broadcasting. The broadcasting method shall be used for sowing seed only in areas inaccessible to mechanical spreading equipment. Seeding during winds above 15 miles per hour (25 km/hr) shall not be permitted.
- B. Prior to placing seed materials, water topsoil to a depth of four (4) inches (100 mm) at least 48 hours prior to seeding operations to obtain a loose friable seed bed. Time and depth of watering operations shall be varied at the direction of ENGINEER for varying conditions at the site of the Work.
- C. Broadcasting methods for sowing seed materials shall be accomplished by spreading one-half of the specified amount of seed in one direction and then broadcasting the remaining one-half of the seed at right angles to the first seeding pattern using the same broadcast method. Rate of broadcast shall be as specified herein or per the written recommendations of the Producer of the seed material used. Roll seeded area with roller weighing a maximum of 150 pounds/foot (225 kg/m) of width.
- D. Hydroseeding shall be performed using suitably acceptable hydraulic seeding equipment and a homogeneous slurry solution of water, seed, fertilizer and suitable mulch material as approved by ENGINEER. Seed slurry mixture shall be distributed uniformly at a rate approved by ENGINEER for the seed materials, fertilizer and/or mulch materials used to suit the seed application rate. Seed application rate shall be 300 lbs/acre (340 kg/ha).

3.07 Mulching

- A. Mulching shall consist of placing a mulch material on areas that have been or are to be seeded. Mulch shall be placed in a loose enough condition so as to allow penetration of sunlight and circulation of air, but thick enough to shade the ground, reduce rate of water evaporation and prevent or reduce erosion by wind or water. Mulch shall be secured with suitably acceptable anchoring material.
- B. For surfaces and slopes on which power equipment can be operated, satisfactory mulching materials include the following:
- C. Small grain wheat straw or grass hay applied at 1-1/2 to two (2) tons per acre (3.5 to 4.5 metric ton/ha) with disc packer, asphalt or netting tie-down.
- D. Wood chips applied at six (6) to nine (9) tons per acre (13.5 to 20.0 metric tons/ha).
- E. Asphalt emulsion alone at 600 to 1,200 gallons per acre (5.5 to 11. kl/ha). (This application is suitable for limited periods of time and where trampling by either people or animals will not occur.)
- F. For surfaces and slopes where power equipment cannot be operated, satisfactory mulching materials include the following:
- G. Straw or grass hay applied at 1-1/2 to two (2) tons per acre (3.5 to 4.5 metric tons/ha), anchored with asphalt or netting tie-down.

- H. Asphalt emulsion alone at 600 to 1,200 gallons per acre (5.5 to 11.0 kl/ha). (Limited to areas where tracking is not a problem.)
- I. Commercially available erosion control netting of jute, paper or biodegradable synthetics.
- J. Continuous filament fiberglass at 1,000 pounds per acre (1100 kg/ha) anchored with 150 gallons (1400 l/ha) of asphalt emulsion.
- K. Anchor straw or hay mulch by the methods as specified herein.
- L. Wood chips will not need anchoring when used on workable slopes.
- M. Commercially manufactured netting and/or fiberglass materials shall be anchored in accordance with the manufacturer's printed instructions for the material used.
- N. Punch and anchor mulch material into soil using mulch anchoring tool. Soil must be moist, free of stones and loose enough to permit disc penetration to a depth of three (3) inches (75 mm).
- 0. Blow on liquid or emulsified asphalt materials with the straw or hay mulch or spray or sprinkle asphalt tie-down materials immediately after mulch is spread.
- P. Apply emulsified asphalt at 0.04 gallons per square yard 0.2 l/m²). Do not apply emulsified asphalt during freezing weather since it contains approximately 50% water. Apply liquid (cut back) asphalt at approximately 0.10 gallons per square yard (0.45 l/m²). Liquid asphalt may be applied during freezing weather since it is cut back with kerosene.

3.08 Conversion from Soil Protection to Permanent Vegetation

- A. Following straw or hay mulching, grass seeding can be made in early spring by broadcasting seed directly into the mulch. Fertilizer or lime, where needed, should be incorporated into the soil before mulching.
- B. Asphalt emulsion alone can be readily incorporated into the soil by ordinary tillage before seeding.
- C. Wood chip mulch may be removed before seeding or incorporated deeply into the soil. If wood chips are incorporated into the soil, the addition of extra nitrogen fertilizer to the soil will be required to provide nitrogen in the new seeding.
- D. Fiberglass mulch shall be removed before seeding because of its permanence. Care shall be taken to prevent fiberglass filaments left in place from becoming entwined or wound around shafts of power mowers or other power equipment.
- E. Acceptable proprietary netting and erosion control materials shall be disposed of in accordance with the manufacturer's printed instructions for the material used prior to any seeding operations.

3.09 Turf Establishment

A. Seeded areas shall be watered whenever excessive drying is evident during the period set for establishment. Watering shall be done in a manner that will prevent erosion due to the application of excessive quantities and the watering equipment shall be of a type that will prevent damage to the cultivated surfaces. CONTRACTOR shall be responsible for the proper care of the seeded areas until final acceptance of the entire Work covered by the Contract.

- B. The seeded areas shall be mowed with mowing equipment acceptable to ENGINEER to a height of two (2) inches (50 mm) whenever the average height of grass establishment reaches four (4) inches (100 mm). When the amount of cut grass is heavy, cut grass shall be removed to prevent destruction of the underlying grass. If weeds or other undesirable vegetation threaten to smother the planted species, such vegetation shall be mowed, or in the case of rank growths, shall be uprooted, raked and legally disposed of from the area.
- C. Reseed and mulch areas larger than four (4) square inches (25 cm²) not having a dense, uniform, vigorous stand of grass acceptable to ENGINEER.
- D. The establishment period shall extend for a period from the time of seeding until the seeded area has a uniform stand of grass acceptable to ENGINEER. The minimum period shall be 30 days.
- E. If after 60 days from the initial seeding a dense, uniform, vigorous stand of grass has not been established by CONTRACTOR, OWNER may reseed the defective areas and all costs will be deducted from CONTRACTOR's payments.

End of Section
Division 33 Utilities

Section 33 3400 Sanitary Utility Force Mains

Part 1 General

1.01 Scope of Work

A. This Section includes underground force main work complete with piping, valves, force main manholes, fittings, thrust blocks, retainers, plugs and accessories required for installation as indicated on the Plans and specified herein. This Section also includes hydrostatic testing of completed portions of new force main.

1.02 Related Work Specified Elsewhere

- A. Section 01 2200: Unit Prices
- B. Section 31 2316: Structural Excavation and Backfill
- C. Section 31 2319: Dewatering
- D. Section 31 2333: Trenching and Backfilling

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. ANSI American National Standards Institute
 - 2. ASTM ASTM International
 - 3. AWWA American Water Works Association
 - 4. MDOT Michigan Department of Transportation, Standard Specifications for Construction, latest addition

1.04 Submittals

- A. Tabulated Laying Schedule:
 - 1. Tabulated Laying Schedule, showing stationing, deflection, elevation, slope and description of pieces (i.e., pipe size and material; fitting type, size and material; valve type and size, etc.) shall be submitted to ENGINEER. Pipe manufacture shall not be started until the laying schedule has been reviewed by ENGINEER.
- B. Product Data:
 - 1. Submit catalog data showing pipe sizes, and manufacturing standards, as well as design calculations for internal pressure, vacuum and external load conditions, for both non-restrained and restrained joints.
- C. Quality Assurance Materials:
 - 1. Quality assurance test procedures, test reports for pipes, specials and fittings shall be submitted to ENGINEER.
- D. Affidavits:
 - 1. Affidavits of compliance with the Contract Documents shall be submitted to ENGINEER and shall include the following, where applicable:

- a. Pipes, specials and fittings (AWWA C200).
- b. Cement-mortar protective lining (AWWA C205 and AWWA C602).
- c. Tape coating for the exterior (AWWA C214 and AWWA C209).
- d. Shrink wrap for exterior (AWWA C216).
- e. Paint system for the exterior (AWWA C210, C218 or C222).
- f. Manufacturer's standard repair procedures.
- g. Manufacturer's written quality control procedures.
- h. Manufacturer's Installation Instructions: Indicate special installation requirements.
- i. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.
- 2. Affidavits for items a through e shall be signed by an authorized professional.

1.02 Closeout Submittals

- A. The following shall be submitted in accordance with Section 01 7700, Closeout Procedures:
 - 1. Manufacturer's field reports.
 - 2. Project record documents:
 - a. Accurately record actual locations of piping mains, valves, connections, and invert elevations.
 - b. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
 - 3. Provide a final record laying schedule.
 - 4. Submit certified copies of hydrostatic test results of completed force main sections as specified in Article 3.15.

1.05 Delivery of Materials

A. For pre-stressed concrete pipe provide 2 percent of pipe lengths to be delivered as short pieces with 10 feet (3 m) or less. These short pieces shall be in addition to those required under the tabulated laying schedule.

1.06 Storage of Materials

A. Pipe shall be stored in a manner to minimize infiltration of dirt, debris, and other extraneous materials.

- B. Piping materials shall not be stacked higher than 4 feet (1.2 m). Suitable racks, chairs, and other supports shall be provided to protect performed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers, and chock tier ends.
- C. Joint and sealing materials subject to ultraviolet or ozone attack and used in the force main system shall be protected from the sunlight, atmosphere and weather, and stored in suitable enclosures until ready for installation.

1.07 Handling of Materials

- A. Load and unload piping using suitable hoists and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. Damaged piping shall not be used by CONTRACTOR.
- B. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

1.08 Environmental Requirements

A. Cast iron or ductile iron pipe joints shall comply with the requirements due to outside ambient air temperatures specified under Article 3.05 of this Section.

Part 2 Products

2.01 General

A. It is the intent of the Articles in Part 2 of this specification section is to specify in detail the various types of pipe, joints, and fittings which have been indicated throughout the Plans and Specifications. These Articles shall not be construed as allowing any alternate type of material to that which is indicated on the Plans or elsewhere in the Specifications.

2.02 Ductile Iron Pipe

- A. Ductile iron pipe shall be ANSI/AWWA C151/A21.51, with double thickness cement mortar lining inside and 1-mil ($25 \mu m$) minimum thickness asphaltic coating outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.
- B. Mechanical joints for ductile iron pipe shall be compression gasket type, conforming to ANSI/AWWA C111/A21.11 except that slots with the same width as the diameter of the bolt holes in mechanical joints shall not be allowed in the bell flange.
- C. Push-on joints for ductile iron pipe shall be compression gasket type conforming to ANSI A21.11 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section.
- D. Fittings and plugs shall be ductile iron, mechanical joint, pressure rating of 350 psi (2.4 MPa), conforming to ANSI/AWWA C153/A21.53, and ANSI/AWWA C111/A21.11, with double thickness cement mortar lining and coal tar enamel coating on the outside of fittings.
- E. Nuts and bolts shall be high strength low-alloy steel conforming to ANSI/AWWA C111/A21.11.
- F. Flexible ball and retainer type joints shall be ball and retainer type, boltless, locking, and capable of being deflected up to 15 degrees.

- G. Flange joints shall have full face neoprene gaskets, 1/8-inch-thick and conform to ANSI B16.1. Carbon steel bolts shall conform to ASTM A449 with nuts conforming to ASTM A563 Grade B. Stainless steel bolts and nuts shall conform to ASTM A320. Bolt head and nuts shall be hex. Piping connection bolts and nuts used on this Project including piping in the wet areas shall be cadmium plated. Flange joints shall not be buried.
- H. Cement mortar lining for cast iron and ductile iron piping shall conform to the requirements of ANSI/AWWA C104/A21.4 of the thicknesses specified and shall be permanently set prior to the application of additional pipe coating.

2.03 Prestressed Concrete Pipe Systems

- A. Concrete pipe shall be prestressed concrete, embedded cylinder type, 175 psi plus load design pressure conforming to AWWA C301. Seal coat in accordance with ANSI/AWWA C104/A21.4 as applicable.
- B. Joints for concrete pipe shall be push-on, steel ring, gasket type conforming to AWWA C300 or AWWA C301.
- C. Fittings shall be AWWA C300, Type A, concrete or mortar lined with reinforced concrete or mortar exterior covering. AWWA C300, Type B, cut and welded steel plate mortar coated on interior and exterior.
- D. Seal coat concrete pipe with bitumastic concrete penetrant conforming to ANSI/AWWA C104/A21.4. Apply after pipe has cured.

2.04 Polyvinyl Chloride (PVC) Piping Systems

- A. Rigid polyvinyl chloride bell and spigot type pressure pipe and couplings conforming to ASTM D2241, SDR 21, pressure class 200, unless indicated otherwise in the Contract Documents. Spigot end of pipe shall be marked to visually determine when the spigot is fully seated in the bell of the adjoining pipe.
- B. Joints for PVC pipe shall be Push-on, elastomeric gasket type, conforming to ASTM D3139.
- C. PVC fittings shall only be allowed when called for on the plans. When allowed, PVC fittings shall be SDR-21, conforming to ASTM D2241, D3139 and F477.
- D. Fittings for PVC pipe, unless specified otherwise, shall be Class 250 psi, manufactured of ductile iron, grade 80-55-06 in accordance with ASTM A536. Fittings shall have mechanical joints with gaskets meeting ASTM F477. Fittings shall have radii of curvatures conforming to ANSI/AWWA C153/A21.53 and shall be cement lined in accordance with AWWA C104.
- E. Gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477.
- F. Pipe joint lubricant shall be manufacturers standard nontoxic.

2.05 Subaqueous Pipe

Pipe shall be ductile iron, ANSI/AWWA C151/A21.51, with double thickness cement mortar lining and 1-mil (25 μm) thickness minimum of coal tar enamel inside and outside. Pipe shall have a minimum wall thickness class for the pipe nominal inside diameter as indicated on the Plans.

- B. Bell assembly shall conform to ANSI/AWWA C153/A21.53, threaded onto pipe in accordance with ANSI B2.1.Spigot shall have raised bead cast with the pipe and machined to form shoulder.
- C. Joint shall be made by a retaining ring and gasket assembly compressed between an outer ring and the shouldered spigot. Steel retaining rings shall seat the gasket inside the spherical bell and provide a positive stop for the spigot. Gasket shall be a high quality molded rubber and duck tipped. Tee head bolts and hexagonal nuts shall be stainless steel.

2.06 Restrained Joints

- A. Where the plans or specifications call for restrained joints they shall be per the following.
- B. Restrained joints for ductile iron pipe and fittings shall be designed for a working pressure of 350 psi (2.4 MPa). Joints shall be capable of being deflected after assembly. Restraints shall be by a positive axial lock between the bell interior surface and a retainer weldment on the spigot end of the pipe.
- C. Restrained joints for PVC force main pipe shall be designed for a working pressure of 200 psi (1.4 MPa). Where the restrained portion of the pipe is connected to fittings, restraint shall be provided across the joint by a clamping ring and anchored to the fitting with T-head bolts or stainless-steel rods. Restraining devices for PVC water main pipe shall incorporate clamping rings with serrations on the inside surface to provide positive restraint on the outside surface of the pipe and shall provide full support around the circumference of the pipe to maintain roundness.

2.07 Polyethylene Encasement

A. Polyethylene material for encasement shall be either 4 mil high density, cross-laminated polyethylene film or 8 mil linear low-density polyethylene film per ANSI/AWWA C105/A21.5.

2.08 Gate Valves

- A. Provide iron body, resilient seated, solid wedge type gate valves with non-rising stems and O-ring seals in accordance with AWWA C509.
- B. Furnish buried valves with mechanical joint ends, stainless steel hardware, and 2" square operating nut. Where the force main is buried at a depth where the normal valve operating nut will be at a depth greater than 5-1/2 feet, a valve extension stem with operating nut shall be provided and mechanically attached to the valve to provide an operating nut at the 5-1/2-foot depth.
- C. Valves shall open counterclockwise.
- D. Gate valves shall be as manufactured by East Jordan, or equal.

2.09 Eccentric Plug Valves

A. Valve body shall be full ported, cast iron and comply with AWWA C504. Inlet and outlet connections shall be compatible with the pipe joints used.

- B. Body seats shall be synthetic rubber reinforced by a nickel alloy conforming to ASTM B127. Seats shall be adequately reinforced and secured to the body to prevent the seat from becoming inflated by the pressure from behind.
- C. Bearings shall be replaceable sleeve-type with one set being thrust resistant to hold the plug securely in the center of the seat. Self-lubricated bearings shall have proven record of durable service.
- D. Shaft seals shall conform to AWWA C504 and C507.

2.10 Air Release Valve

- A. Air Release valves shall have an ASTM A126 Class B cast iron body and cover with a threaded inlet connection of the size shown on the plans or listed in the schedule and a 1/2-inch NPT outlet connection. Valve body shall have a 2-inch NPT plugged port near the base to facilitate cleanout of large solids as well as a 1/2-inch NPT connection near the top and 1-inch NPT port near the bottom to permit the installation of flushing attachments.
- B. Valves shall have an 18-8 stainless steel float and a replaceable seat of Buna-N or other suitable material. Internal linkage mechanism shall be 18-8 stainless steel, plastic or bronze is not acceptable. Linkage mechanism shall be capable of being removed from the cover without disassembly of the mechanism. Valves shall have 3/16-inch diameter stainless steel orifice for working pressures up to 150 PSI.
- C. Provide flushing attachments to include 1/2-inch flushing valve, 1-inch blowoff valve, 5 feet of rubber hose and quick disconnect couplings.
- D. Valve shall automatically exhaust accumulated air from a fluid system while the system is pressurized and operational.

2.11 Combination Sewage Air Release and Vacuum Valves

- A. Wastewater combination air valves shall be constructed of cast iron body and cover, stainless steel plug, guide shaft, bushings and float, Buna-N seat.
- B. Valves shall be automatic float operated valve designed to releases air, gas or vapor during filling of a force main and close upon liquid entry, and allow air to re-enter when draining or under a negative pressure.
- C. Valve shall also release accumulated air from a force main while the system is in operation and under pressure. Valves shall have working pressure of 150 psi (1000kPa).
- D. CONTRACTOR shall provide a backwash system to be included with the valves consisting of an inlet shut-off valve, blow-off valve, clear water inlet valve and rubber supply hose with quick disconnect couplings.

2.12 Concrete Brick

A. Concrete brick shall be ASTM C55, Grade S-II, solid units of nominal 3-inch (75 mm) thickness.

2.13 Concrete Block

A. ASTM C139, Type II, shape and scored as detailed and as approved.

2.14 Precast Concrete Units

- A. Precast concrete units, flat top slabs, riser, cone, transition sections and bottom sections shall conform to ASTM C478, and shall be circular with circular reinforcement. For depths greater than 32-feet, the manhole shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5. Base slab shall be eight (8) inches (200 mm) thick for depths up to 25 feet (7.5 m) and 12 inches (300 mm) thick for depths greater than 25 feet (7.5 m).
- B. Transition sections, reducers and flat top slabs shall be designed for the earth loading at the design depth of bury with a factor of safety of 1.5.
- C. Precast bottom sections shall be cast with the bottom end flat to provide bearing of the full wall thickness. Openings for sewer pipe shall be cast in the manhole and the bottom section by the manufacturer.
- D. Riser sections of a manhole shall have modified grooved tongue joints with "0" ring gaskets.
- E. Eccentric cone sections of a manhole shall have modified grooved tongue joints with "O" ring gaskets and be provided with 4-stud inserts cast in the top. The top shall have a smooth finished surface.
- F. Concrete grade rings shall have smooth finished top and bottom surfaces. Grade rings shall be provided with "O" ring gaskets.

2.15 Manhole Steps

- A. Cast iron manhole steps shall be ASTM A48, Class 35, with a minimum cross section dimension of 1-inch (25 mm) in any direction.
- B. Steel Reinforced plastic manhole steps shall be suitably approved co-polymer polypropylene conforming to ASTM D4101, PP0344B33534Z02 with 1/2 inch (12 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60 and shall be in accordance with ASTM C478.
- C. Manhole steps shall be of types and sizes indicated on the Plans and shall comply with applicable state and federal occupational and safety standards.

2.16 Covers and Frames

A. Structure frame and covers shall be of the types and sizes as detailed on the Plans. Covers shall be Class 30, ASTM A48 gray iron castings. The castings shall be neatly made and free from cracks, cold sheets, holes and other defects. Surfaces of castings shall be ground to assure proper fit and to prevent rocking.

2.17 Valve Boxes

A. Three-piece, 5-1/4-inch (135 mm) diameter, screw type, gray iron castings conforming to ASTM A48, Class 20 with adjustable length. Lids shall have "Sanitary Force Main" plainly cast in tops.

2.18 Concrete

A. In accordance with MDOT Section 701, use Grade S2; 3,500 psi (24 MPa) strength; Type IA cement; 6.0 sacks cement per cubic yard (355 kg/m³); 6A coarse aggregate; 2NS fine aggregate; 5% ±1% air content; 3-inch (75 mm) maximum slump; no admixtures without the ENGINEER's approval.

2.19 Concrete Reinforcement

A. In accordance with MDOT Section 905, use ASTM A615, Grade 60 for bars and ASTM A185 for welded wire fabric.

2.20 Restraints, Clamps, Rods, and Ties

A. Cast iron or stainless steel as recommended by pipe manufacturer. Bolts, nuts, clamps, rods, ties and fittings shall be bronze alloy or corrosion protected steel.

2.21 Tracer Wire

- A. Copper clad steel wire with 30 mil High Density Polyethylene (HDPE) insulation. Concentric copper cladding metallurgically bonded to a steel core through a continuous solid cladding process.
- B. Copper cladding to measure 3% minimum of the overall wire diameter. Wire to be 12 AWG, 0.0808 in. diameter, 0.00242-inch nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength.
- C. Wire to be Copperweld® or equal.

2.22 Acceptable Manufacturers

- A. PVC Pipe Transition Gland or Gasket: Acceptable manufacturers include Mueller, Tyler, or equal.
- B. Combination Air Valves: Acceptable manufacturers include Apco, Val-matic, or equal.
- C. Valve Boxes: Acceptable manufacturers include Clow "F-2450," or equal.
- D. Restrained Joints: Acceptable manufacturers for restrained joints for ductile iron pipe include Griffin Pipe Products Company, "Snap-Lok" or "Bolt-Lok"; American Cast Iron Pipe Company, "Lok-Ring" or "Lok-Fast"; United States Pipe and Foundry Company, "TR Flex"; Ebaa Iron "Megalug" or ENGINEER approved equal.
 - 1. Manufactured in accordance with ANSI/AWWA C111.
 - 2. A tightly adherent, corrosion resistant coating shall be used on all exposed metal components of the restrained joint system.
 - a. Wedges, actuating hardware or other exposed threaded components shall be coated with a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
 - b. Primary restraint castings shall be coated with a polyester coating, electrostatically applied and fusion bonded.

- c. Bolts, nuts, and washers shall be manufactured of low-allow steel conforming with the material characteristics listed in ANSI/AWWA C11 and shall have a minimum of two (2) coats of fluoropolymer epoxy coating that has been heat cured.
- E. Fittings for IPS/PVC Pipe: Harco manufactured by the Harrington Corporation.

Part 3 Execution

3.01 CONTRACTOR's Verification

A. Prior to the installation of any force main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that excavation bottoms, compacted subgrades and pipe bedding are adequate to receive force main materials to be installed. Correct defects and deficiencies before proceeding with the Work.

3.02 Preparation of Pipe Ends

A. Remove all lumps, blisters and excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of plain ends and the inside surfaces of socket ends before installation. Pipe or fitting which has acquired a coating of mud or other adhesive foreign material shall be scrubbed clean.

3.03 Examination of Materials

A. Pipe fittings, accessories, and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be rejected and removed from the Project by CONTRACTOR.

3.04 Installation - General

- A. Foreign matter shall be prevented from entering the pipe while it is being placed in the trench. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe. Plug pipe ends when construction stops overnight or for extended periods.
- B. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes.
- C. Cutting of pipe shall be done with approved tools and by approved methods suitable for the pipe material. Pipe cutting methods that produce a smooth, square-cut end without damage to the pipe and that minimize airborne particles, shall be employed. Pipe cutting shall be performed using the recommendations of the manufacturer of the pipe materials being cut and according to the best trade practices.
- D. When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.
- E. Where pipe using a resilient gasket to affect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burrs which might damage the gasket.

- F. Provide restrained joints meeting this specification and as recommended by the manufacturer. Connection shall be made in accordance with manufacturer's recommendations.
- G. After the bottom of trench has been excavated, the pipe bedding material will be installed in accordance with Section 31 2333, Trenching and Backfilling. Pipe shall then be installed strictly in accordance with the manufacturer's recommendations.
- H. After the pipe is laid, the bedding shall be continued above the pipe as specified in Section 31 2333, Trenching and Backfilling. Particular care shall be taken to assure filling and tamping spaces under, around and above the top of the pipe.
- I. A continuous and uniform bedding as specified in Section 31 2333, Trenching and Backfilling, shall be provided in the trench for all buried pipe.
- J. Unless otherwise specified, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell end of the adjacent pipe section, the pipe shoved into position and brought to true alignment and secured. Adequate support shall be provided for all force main pipe.
- K. Backfill shall be as indicated on the Plans and as specified in Section 31 2333, Trenching and Backfilling.
- L. Fittings, plugs, adapters, and horizontal and vertical blocking shall be installed by CONTRACTOR as shown on the Plans; and the cost of the same shall be included in the unit price per lineal foot of force main.

3.05 Installation of Ductile Iron Pipe

- A. Push on joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be pre-lubricated before installation using a lubricant recommended by the pipe manufacturer. Seated joint shall be identified by the visible mark on the spigot of the installed pipe section.
- B. When the temperature is above 60 degrees Fahrenheit (15 degrees Celsius), the spigot end of each pipe lead shall be forced tightly on the bell of the proceeding pipe. When the temperature is below 60 degrees Fahrenheit (15 degrees Celsius), the pipe shall be laid with the spigot end 1/16-inch (1 mm) from the face of the bell for expansion.
- C. Mechanical joints shall be made with bolts, molded resilient gasket and cast iron follower gland. Nuts shall be screwed up finger tight before using a wrench. The gland and rubber gasket shall be brought up evenly at all points around the bell flange and then torqued per the manufacturers recommendations.
- D. Exposed portions of bolts shall be covered with mastic.
- E. Flexible joint pipe shall be assembled, handled and installed in accordance with the printed recommendations which accompanies the pipe and is provided by the manufacturer of the piping materials being installed. Methods of handling and installation shall be acceptable to ENGINEER.

3.06 Installation of Concrete Pipe

- A. Concrete pipe and fittings shall be jointed by means of a resilient gasket and steel spigot ring. Resilient gasket shall be lubricated and installed to form a watertight joint between the bell and spigot of the pipe.
- B. Pipe shall be laid in accordance with the accepted tabulated laying schedule and the Plans.
- C. Short lengths of pipe (ten (10) feet or less) (3 m) specified under Article 1.05 of this Section shall be installed and evenly distributed along the line of the Work, if required.
- D. Bell of the pipe in place shall be cleaned and properly lubricated and pipe section installed. After the spigot is well entered into the bell and the gasket is fully compressed and brought to final shape, prior to driving the pipe home, check each gasket for proper position around the full circumference of the joint and complete installation.
- E. Provide cloth bands wired around each joint outside diameter and grout with Portland cement mortar grout. Completely fill the annular recess between the adjoining bell and spigot pipe ends. Annular spaces between pipe ends on the inside of joints of pipe 24 inches (600 mm) or more in diameter shall be filled with Portland cement mortar grout.

3.07 Installation of Polyvinyl Chloride Pipe

- A. Polyvinyl chloride pipe shall be laid with gasketed joints in complete accordance with the pipe manufacturers published instructions. Joints shall be sufficiently lubricated using the pipe manufacturers recommended lubricant.
- B. Gaskets for pipe joints shall be inserted with the painted edge facing the end of the bell. Each length of pipe shall be pushed home individually. Pipe shall be positioned so that the reference mark on the spigot end is in line with the bell end.
- C. When called for on the plans or in the specifications, tracer wire is to be installed along with the force main. Tracer wire is to be continuous from end to end and terminate at each structure in such a way and with a sufficient length of wire to allow for easy connection to utility tracing equipment. Wire shall be continuity tested after installation. Any wire which fails the continuity test shall be replaced.

3.08 Subaqueous Pipe

A. Provide sections of pipe with joints for subaqueous trench installation as indicated on the Plans. Sections of pipe shall be assembled, bedded and backfilled before connecting to land lines. Sections shall be assembled on shore, then dragged or floated into position for installation. Joints of pipe lengths and connections to land lines shall be in accordance with manufacturer's recommendations.

3.09 Installation of Restrained Joints

A. Restrained joints shall be provided where indicated on the plans. Joints shall be assembled in strict accordance with manufacturer's directions. Joints shall be fully extended after assembly.

3.10 Polyethylene Encasement

A. Where called for on the plans, ductile iron fittings and pipe shall be encased in a polyethylene film tube. Polyethylene film tube shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Method A consists of cutting the polyethylene tube two feet (600 mm) longer than the pipe to provide an overlap at the joints. Cost of the polyethylene encasement shall be incidental to the water main.

3.11 Anchors and Thrust Blocks

A. Anchors, encasements and restraints shall be provided at the locations and dimensions as indicated on the Plans. Anchoring, encasement and restraint methods shall be as detailed. Bearings shall be as shown. Anchors, encasements and restraints shall rest on firm, stable, compacted bedding and shall be provided for standard and special fittings.

3.12 Valves

- A. Valves shall be installed to the grade, lines, levels and locations indicated on the Plans.
- B. Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.
- C. Where required, valves shall be supported with special supports as indicated on the Plans and as approved by ENGINEER. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.
- D. Provide all materials and install air release and vacuum release valve assemblies at locations indicated on the Plans. Include all valves, reducers, connections and other fittings necessary for installation. Fittings and joint materials shall be compatible to the force main piping material.

3.13 Valve Boxes

A. Install valve boxes to the grade, lines, levels and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.14 Structures

- A. Construct structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be complete with concrete bases, reinforcing, frames, covers, adjustment rings, etc., as shown and as required for a complete installation. Construction of structures shall conform to the type of construction and dimensions indicated on the Plans and as described below.
 - 1. Brick Structures:
 - a. Prior to laying, all brick shall be thoroughly wetted and the surfaces allowed to dry only sufficiently to prevent slippage on the mortar.
 - b. Broken or chipped brick shall not be used on the faces of the structures.

- c. Brick shall be laid in neat, even consecutive courses with full and close mortar joints.
 - (1) Courses shall be level throughout, except as shown or otherwise required.
 - (2) Stagger joints in adjoining courses by one-half a brick as nearly as practicable.
 - (3) At least 1 course in every 7 shall be stretcher courses with intervening courses laid as headers.
 - (4) Length of brick closure pieces shall be not less than the width of 1 whole brick and, wherever practicable, closures as headers, shall be made from whole brick.
- d. Unless otherwise indicated, joints shall be not more than 1/2 inch (10 mm) thick and shall be of a uniform thickness throughout the structure. Joints shall be provided as indicated on the Plans.
 - (1) Exposed surfaces shall be true and smooth.
 - (2) Rake all joints to receive plaster coat.
- e. Prior to applying plaster coat, brick shall be thoroughly wetted with water and the surface allowed to dry sufficiently to effect proper bonding.
- 2. Block Structures:
 - a. Construct concrete block structures in the locations and according to the details on the Plans.
 - (1) The first course of concrete blocks shall be places on the prepared base or footings in a full bed of mortar.
 - (2) Mortar joints shall be full and close in all courses.
 - (3) Courses shall be level throughout.
 - (4) Stagger joints in adjoining courses by one-half the length of the block as nearly as practicable.
 - b. Joints shall be uniform in thickness throughout the structures. Strike joints and properly point to provide true, smooth surfaces.
- 3. Precast Structures:
 - a. Construct precast concrete structures as detailed on the Plans. Provide mortar joints struck smooth. Provide 2 to 4 courses of 3-inch (75 mm) brick at top of structure for future adjustment.
 - b. Cement mortar plaster coat shall be applied to the exterior surfaces of all brick or block force main structures indicated on the Plans. Plaster coat shall be 1/2 inch (10 mm) thick and shall be applied to the outer surfaces of the structures.

- c. Provide and install to the elevations shown all cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 1/2-inch (10 mm) thick minimum. Mortar joints shall be struck smooth.
- d. Install steps on 16-inch (400 mm) centers (minimum) for structures of types and in locations indicated on the Plans.
- e. Pipe placed in structures for inlet or outlet connections shall extend through the walls and beyond the outside wall surfaces a sufficient distance to allow for complete connections. Openings between pipes and walls shall be sealed with a full bed of cement mortar. Pipe shall be supported by concrete supports.

3.15 Hydrostatic Testing

- A. After the pipe has been laid and backfilled, the pipe shall be hydrostatically tested for leakage.
- B. CONTRACTOR shall furnish the pump, pipe connection, blow-off valves and all other necessary apparatus including gages and meters and personnel necessary for conducting the test.
- C. Before applying the test pressure, all air shall be expelled from the pipe. If necessary, threaded taps shall be made at the points of higher elevation and then closed with brass plugs.
- D. Faulty pipe fittings, valves or other accessories which permit leaks during testing shall be replaced by CONTRACTOR with sound material and the test shall be repeated until specified requirements are met.
- E. When practicable, tests shall be made on sections between valves, or sections not exceeding 2,000 feet (610 m) in length. Dead ends, bends and other fittings shall have a firm foundation and be securely blocked against the trench walls before testing or completing the backfill as specified.
- F. Full test pressure shall be held for no less than one (1) hour or longer as necessary to permit thorough examination of all exposed joints in the section of main being tested. Test pressure shall be maintained at 150 psi (1000 kPa) for force mains.
- G. Leakage shall be measured by the quantity of water pumped into the pipe to maintain test pressure during test period. Leaks shall be located and repaired until the test meets the the minimum requirements stated herein. Maximum permissible leakage of force main shall not exceed the following:

| Force Main Diameter inches (mm) | Allowable Leakage gallons/1,000 feet/hour (liters/0.5 km/hour) |
|------------------------------------|---|
| 4 (100) or less | 0.5 (3.0) |
| 6 (150) | 0.75 (4.5) |
| 8 (200) | 1.00 (6.0) |
| 10 (250) | 1.25 (8.0) |
| 12 (300) | 1.50 (9.0) |
| 14 (350) | 1.75 (11.0) |
| 16 (400) | 2.00 (12.5) |
| 18 (450) | 2.25 (14.0) |

| Force Main Diameter inches (mm) | Allowable Leakage gallons/1,000 feet/hour (liters/0.5 km/hour) |
|------------------------------------|---|
| 20 (500) | 2.50 (15.5) |
| 22 (550) | 2.75 (17.0) |
| 24 (600) | 3.00 (18.5) |

3.16 Water for Testing

- A. Water for testing shall be obtained from a water source approved by ENGINEER. CONTRACTOR shall provide all water required at his own expense and shall make necessary arrangements with the authority which controls the source of water system and shall be governed in his use of water by all rules and regulations imposed thereon by said authority.
- B. CONTRACTOR shall provide and remove temporary connections between the source water system and the mains constructed under this Contract.
- C. Temporary connections shall meet the approval of ENGINEER, the authority controlling the source water system and authorities having jurisdiction.
- D. Water for testing shall be removed from the force main by pumping to waste. Water discharge shall be controlled adequately to protect any surface water resource or adjacent property from potential environmental damage or from creation of hazard to traffic.

3.17 Flushing Force Main

- A. Should the force main flows not meet design requirements, CONTRACTOR shall flush the force main at no additional cost to OWNER.
 - 1. Flushing shall be done using the "poly-pig" method of flushing and CONTRACTOR shall furnish foam "poly-pig" swabs to be used.
 - 2. Prior to pigging and flushing, the force main must be charged with water.
 - 3. CONTRACTOR shall insert "poly-pig" swab in the end of the new main nearest the pump station (or where shown on the Plans).
 - 4. The swab shall be passed through the new main using water pressure.
 - 5. The swab shall be recovered at the end of the main or cleanout.

End of Section

Section 33 3410 High Density Polyethylene (HDPE) Pipe and Fittings

Part 1 General

1.01 Scope of Work

A. CONTRACTOR shall furnish labor, materials, equipment, and incidentals required to install High Density Polyethylene (HDPE) pressure pipe, fittings, and appurtenances as shown on the Drawings and specified in the Contract Documents.

1.02 Related Work Specified Elsewhere

- A. Section 01 8933: Bypass Pumping
- B. Section 33 3410.15: Leakage Testing for High Density Polyethylene Pipe

1.03 Reference Standards

- A. Work shall conform to applicable provisions of the Contract Documents and to the latest edition of following standards, except as modified in this Section:
 - 1. AWWA C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch, for Water Distribution
 - 2. ASTM D1248: Standard Specifications for Polyethylene Plastics Molding and Extrusion Materials
 - 3. ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
 - 4. ASTM D3035: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
 - 5. ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
 - 6. ASTM E3261: Standard Specification for Butt Heat Fusion Polyethylene Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings Materials
 - 7. ASTM F2164: Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

1.04 Submittals

- A. Detailed Plans and Shop Drawings:
 - 1. Submittals shall be made in accordance with Section 01 3300, Submittals, and shall include:
 - a. A list of materials to be furnished, the names of the suppliers, and the appropriate shop drawings for HDPE pipe and fittings;

- b. Pipe manufacturer's certification of compliance with the applicable sections of the Specifications; and
- c. Shop drawings showing installation method and the proposed method and specialized equipment to be used.
- B. Permits and Inspection Records:
 - 1. Prior to beginning any horizontal directional drilling operations, submit copies of all permits and inspection records obtained from state and local authorities having jurisdiction as described under Article 1.03 of this Section.
- C. Record Drawings:
 - 1. Submit as-built records, in duplicate, within five (5) days of Substantial Completion. As-built records shall include plan, profile, and information recorded during the progress of the Work, including subsurface anomalies.

1.05 Quality Assurance

- A. Qualification of Manufacturer:
 - 1. HDPE pipe, fittings, and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the items to be furnished.
 - 2. Manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these Specifications.
- B. Requirements of Regulatory Agencies:
 - 1. Federal, State, and Local Regulations: Conform to the requirements of federal, state, and local regulatory agencies having jurisdiction.
- C. Permits and Inspections:
 - 1. Where applicable, obtain and pay for permits and inspections for horizontal directional drilling operations as required by PA 451, State of Michigan, 1994, and all government and private agencies having jurisdiction.
 - 2. No additional compensation shall be allowed because of CONTRACTOR's failure to obtain and pay for such permits and inspections.
 - 3. CONTRACTOR shall be aware of, and conform to, OWNER-obtained permits.

1.06 Warranty and Acceptance

A. Warrant Work to be free from defects in workmanship and materials for a period of one year from the date of completion of construction. If Work meets these specifications, a letter of acceptance, subject to the one year warranty period, shall be given at the time of completion.

- B. A final acceptance letter shall be given upon final inspection at the end of the one year warranty period, provided the work still complies with these specifications.
- C. In the event deficiencies are discovered during the warranty period, they shall be corrected by CONTRACTOR without additional charge to OWNER before final acceptance.
- D. During the warranty period, ENGINEER shall determine if warranty repairs or replacement work shall be performed by CONTRACTOR.

Part 2 Products

2.01 High Density Polyethylene (HDPE) Pipe and Fittings

- A. Fabrication:
 - 1. Pipe and fittings shall be PE3408 high density polyethylene meeting cell classification of 345434E/C per ASTM D3350.
 - 2. Pipe and fittings shall be manufactured in accordance with ASTM F714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter; or ASTM D3035, Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter. Piping shall bear markings indicating either SDR-PR or DR-PR.
 - 3. Pipes and fittings shall be suitable for use as pressure conduits, listed as NSF 14 and NSF 61, and per AWWA C906 Pressure Class100 have a nominal burst value of three and one-half times the Working Pressure Rating of the pipe.
- B. Pipe Identification:
 - 1. The following shall be continuously indent printed on the pipe, or spaced at intervals not exceeding 5 feet:
 - a. Name and/or trademark of the pipe manufacturer
 - b. Nominal pipe size
 - c. Dimension ratio
 - d. The letters "PE" followed by the polyethylene grade in accordance with ASTM D1248 followed by the hydrostatic design basis in pounds per square inch (psi).
 - e. Service identification by co-extruding multiple equally spaced color stripes into the pipe outside surface or by solid colored pipe shell. Striping material shall be the same material as the pipe material except for color. The following colors shall be used to identify piping service:

| (1) | Blue | Potable Water |
|-----|-------|--------------------------|
| (2) | Green | Wastewater or Force Main |
| (3) | Black | Raw Water |

- C. Fittings:
 - 1. General:
 - a. Molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. Fittings shall be molded or fabricated by the manufacturer. CONTRACTOR-fabricated fittings shall not be permitted unless approved by ENGINEER.
 - b. Manufacturer of the HDPE pipe shall supply HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.
 - c. Fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by ENGINEER.
 - d. Transition from HDPE pipe to ductile iron or PVC shall be made per the approval of ENGINEER and per HDPE pipe manufacturer's recommendations and specifications.
 - e. A molded flange connector adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A 316 stainless steel back-up ring shall mate with a 316 stainless steel flange per ANSI B16.1.
 - (1) Transition from HDPE to ductile iron fittings and valves shall be approved by ENGINEER before installation.
 - (2) No solid sleeves shall be allowed between such material transitions.
 - 2. Polyethylene Fittings and Custom Fabrications:
 - a. Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer.
 - b. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe.
 - c. Fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.
 - 3. Molded Fittings:
 - a. Molded fittings shall be manufactured in accordance with ASTM D3261 and shall be so marked.
 - b. Each production lot of molded fittings shall be subjected to the tests required under ASTM D3261.

- 4. Fabricated Fittings:
 - a. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings.
 - b. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating pipe.
 - c. Directional fittings 16 inches IPS and larger such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets.
 - d. Part drawings shall be submitted for the approval of the ENGINEER.
- 5. Polyethylene Flange Adapters:
 - a. Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder.
 - b. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasketless sealing, or to restrain the gasket against blow-out.
- 6. Back-up Rings and Flange Bolts:
 - a. Flange adapters shall be fitted with lap joint flanges pressure rated equal to or greater than the mating pipe.
 - b. Lap joint flange bore shall be chamfered or radiused to provide clearance to the flange adapter radius.
 - c. Flange bolts and nuts shall be Grade 2 or higher.

2.02 Tracer Wire

- A. Two strands of copper clad steel wire with 30 mil high density polyethylene insulation shall be installed.
- B. Concentric copper cladding shall be metallurgically bonded to a steel core through a continuous solid cladding process.
- C. Copper cladding to measure 3% minimum of the overall wire diameter.
- D. Wire to be 12 AWG, 0.0808 inches in diameter, 0.00242 inches nominal copper thickness, 9.5270 ohms nominal resistance per 1,000 feet, 675 pounds breaking strength.

Part 3 Execution

3.01 Preparation

A. Layout of the Work:

- 1. Stake, mark, and layout the Work using suitable stakes and markers to facilitate verification of grades, lines, levels, and locations of the Work to be performed in a manner acceptable to ENGINEER.
- 2. From reference points established by ENGINEER on the surface of the ground, carry line and grade down to the bottom of any shafts or boring pits. Perform the Work to the line and grades established; protect such reference points throughout the progress of the Work.
- B. Examination of Materials:
 - 1. Prior to performing any installation Work, examine pipe for damage including but not limited to cracks, breaks, bends, dents, broken ends, or other damage which might affect the structural integrity, performance requirements, or jointing as shown on the Plans, specified herein, or as directed by ENGINEER.
 - 2. Defective pipe removed from the site and replaced with pipe at the expense of CONTRACTOR.

3.02 Installation of HDPE Pipe And Fittings

- A. HDPE pipe shall be installed by direct bury, directional bore, or a method approved by OWNER/ENGINEER prior to construction.
- B. Installation shall be in accordance with Manufacturer's recommendations and this specification. Necessary precautions shall be taken to ensure a safe working environment in accordance with the applicable codes and standards.

3.03 Heat Fusion Joining

A. Joints between plain end pipes and fittings shall be made by butt fusion, and joints between the main and saddle branch fittings shall be made using saddle fusion using only procedures that are recommended by the pipe and fitting Manufacturer. External and internal beads shall not be removed.

3.04 Mechanical Joining

- A. General:
 - 1. Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections (flange adapters and back-up rings) or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another material.
 - 2. Mechanical couplings shall be fully pressure rated and fully thrust restrained such that when installed in accordance with manufacturer's recommendations, a longitudinal load applied to the mechanical cooling will cause the pipe to yield before the mechanical coupling disjoins.
 - 3. External joint restraints shall not be used in lieu of fully restrained mechanical couplings.
- B. Installation:

- 1. Mechanical joints and flange connections shall be installed in accordance with the Manufacturer's recommended procedure.
- 2. Flange faces shall be centered and aligned to each other before assembling and tightening bolts. In no case shall the flange bolts be used to draw the flanges into alignment.
- 3. Bolt threads shall be lubricated, and flat washers shall be fitted under the flange nuts. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the manufacturer.
- 4. At least one hour after initial assembly, flange connections shall be retightened following the tightening pattern and torque step recommendations of the Manufacturer. Final tightening torque shall be 100 ft-lbs or less, as recommended by the Manufacturer.

3.05 Branch Connections

A. Branch connections to the main shall be made with saddle fittings or tees. Polyethylene saddle fittings shall be saddle fused to the main pipe.

3.06 Foundation and Bedding

A. Pipe shall be laid on grade and on a stable foundation in accordance with Section 33 1100, Water Utility Distribution Piping, and/or Section 33 3400, Sanitary Utility Force Mains.

3.07 Testing

- A. Butt Fusion Testing:
 - 1. On days when butt fusions are to be made, the first fusion of the day shall be a trial fusion.
 - a. The trial fusion shall be allowed to cool completely prior to cutting out test straps.
 - b. Tests strap shall be 12 inches (min) or 30 times the wall thickness in length with the fusion in the center, and 1 inch (min) or 1.5 times the wall thickness in width.
 - c. Test straps shall be bent until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely, and tested.
 - d. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.
 - 2. Perform butt fusion joints in the presence of ENGINEER or ENGINEER's representative. Record the temperature and corresponding time for each fusion joint.
- B. Hydrostatic Pressure Testing: HDPE pipes shall be pressure tested in accordance with Section 33 3410.15, Leakage Testing for High Density Polyethylene Pipe.

End of Section

Section 33 3410.15 Leakage Testing for HDPE Pipe

Part 1 General

1.01 Scope of Work

- A. Work specified in this section consists of testing for signs of leakage in pipelines and structure to ensure they are watertight. CONTRACTOR shall furnish labor, equipment, air, water and other materials, including meters, gauges, smoke producers, blowers, pumps, compressors, fuel, bulkheads and accessory equipment for the complete and proper testing of specified utilities.
 - 1. Test gravity sewers and drain lines by low pressure air testing.
 - 2. Test all other pipelines with water under the specified pressures.

1.02 Related Work Specified Elsewhere

- A. Section 01 8933: Bypass Pumping
- B. Section 33 3410: High Density Polyethylene (HDPE) Pipe and Fittings

1.03 Submittals

- A. The following shall be submitted in accordance with Section 01 3300:
 - 1. Pre-Testing Report: Prior to placing the sewer system in service, CONTRACTOR shall submit to ENGINEER a detailed bound report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based.
 - 2. Post Resting Report: Following leakage testing, CONTRACTOR shall submit to ENGINEER a detailed bound report summarizing the leakage test data, including:
 - a. Length and diameter of section to tested (manhole to manhole);
 - b. Location of all service laterals and their status (active or inactive);
 - c. Type of plugs used and where;
 - d. Depth of sewer, and ground water pressure over pipe;
 - e. Stabilization time period and air pressure;
 - f. Actual air test pressures used if ground water is present;
 - g. The allowed time by specifications versus the actual test time;
 - h. The air pressure at beginning and end of test;
 - i. The name of the person performing the testing;
 - j. Date(s) and time(s) of testing, including any retesting; and,
 - k. Description of any repairs made following testing.

1.04 Reference Standards

- A. ASTM F1417-92: Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
- B. ASTM F2164-02: Field Leak Testing of Polyethylene Pressure Piping System Using Hydrostatic Pressure

Part 2 Products (Not Used)

Part 3 Execution

3.01 General

A. New HDPE pipelines installed shall be tested for leakage. Tests to be performed shall be witnessed by ENGINEER.

3.02 Flushing

- A. Mains shall be flushed to remove sand and other foreign matter.
- B. The velocity of the flushing water shall be at least 4 feet per second (fps).
- C. Flushing shall be terminated at the direction of ENGINEER.
- D. Dispose of the flushing water without causing a nuisance or property damage.
- E. Temporary flush out connections shall be installed on all dead end water mains at the locations shown on the Drawings.

3.03 Restrain Against Movement

- A. Before applying pressure, all piping and all components in the test section must be restrained. This means that if piping or parts move or separate during the test, it will not result in damage or injury. Never conduct leak tests on unrestrained piping.
 - 1. Heat fusion joints must be properly cooled before testing.
 - 2. Mechanical connections must be completely installed and tightened per manufacturer's instructions.
 - 3. If backfill provides restraint, it must be properly placed and compacted. Joints and connections may be exposed for inspection.
 - 4. End closures must be suitable for pressure service and pressure-rated for the test pressure.
 - 5. Ensure that connections to test equipment are secure. Disconnect or isolate all low pressure filling lines and other parts that are not to be subjected to test pressure. Restrain, isolate or remove expansion joints before leak testing.

3.04 Test Section

- A. Testing may be conducted on the full system or in sections. Test section length is determined by the capacity of the testing equipment. Lower capacity pressurizing or filling equipment may not be capable of completing the test within permissible time limits. If so, use higher capacity test equipment or select a shorter test section.
- B. Before applying test pressure, allow time for the test fluid and the test section to equalize to a common temperature.

3.05 Test Pressure

- A. For pressure piping systems that include polyethylene pipe or fittings:
 - 1. The maximum permissible test pressure is measured at the lowest elevation in the test section.
 - 2. The maximum permissible test pressure is the lower of (a) 150% of the system design operating pressure provided that all components in the test section are rated for the test pressure, or (b) the pressure rating of the lowest pressure rated component in the test section.
- B. For leak testing purposes, the maximum allowable test pressure in polyethylene pipe is 150% of the pipe's design pressure rating for the application and the application service temperature.
- C. Do not subject lower pressure rated, non-polyethylene parts or devices to pressures above their pressure rating. Lower pressure rated parts may be removed or isolated from the test section to avoid damage or failure. Vent isolated parts or equipment to atmosphere.
- D. Thermoplastic pipes have reduced strength at elevated temperature. Test pressure must be reduced when the test section is at elevated temperature either from service conditions or from environmental conditions such as being warmed by the sun. Multiply the test pressure by the multiplier shown in the table below to determine the allowable elevated temperature test pressure.

| Test Section Temperature °F (°C) | < 80 (< 27) ¹ | < 90 (< 32) | <100 (< 38) | <110 (< 43) | < 120 (< 49) | < 130 (< 54) | < 140 (< 60) ² |
|---|-----------------------------|----------------|----------------|----------------|-----------------|-----------------|------------------------------|
| Multiplier | 1.00 | 0.90 | 0.80 | 0.75 | 0.65 | 0.60 | 0.50 |
| ¹ Use the 80°F (27°C) multiplier for 80°F (27°C) and lower temperatures. ² The maximum service temperature for polyethylene pressure piping is 140°F (60°C). | | | | | | | |

3.06 Test Duration

- A. When testing at pressures above system design pressure up to 150% of the system design pressure, the maximum test duration is eight (8) hours including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize the test section.
 - 1. If the test is not completed due to leakage, equipment failure, or for any other reason, depressurize the test section completely, and allow it to relax for at least eight (8) hours before pressurizing the test section again.
- B. Testing at excessive pressure or for excessive time may damage the piping system.
- C. When testing at system design pressure or less, test duration including time to pressurize, time for initial expansion, time at test pressure and time to depressurize should be limited to a practical time period given that the test section is not to be left unsupervised at any time during leak testing.

3.07 Hydrostatic Leak Testing

- A. This hydrostatic leak test procedure consists of filling, an initial expansion phase, a test phase, and depressurizing. There are two alternatives for the test phase.
 - 1. Filling:
 - a. Fill the restrained test section completely with test liquid; ensure that there is no air trapped in the test section. Failure with entrapped air can result in explosive release and result in death or serious bodily injury. Use equipment vents at high points to remove air.
 - 2. Initial Expansion Phase:
 - a. Gradually pressurize the test section to test pressure, and maintain test pressure for three (3) hours. During the initial expansion phase, polyethylene pipe will expand slightly. Additional test liquid will be required to maintain pressure. It is not necessary to monitor the amount of water added during the initial expansion phase.
 - 3. Test Phase Alternate 1:
 - a. Immediately following the initial expansion phase, reduce test pressure by 10 psi, and stop adding test liquid.
 - b. If test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.
 - 4. Test Phase Alternate 2:
 - a. This alternative is applicable when the test pressure is 150% of the system design pressure. Immediately following the initial expansion phase, monitor the amount of make-up water required to maintain test pressure for one (1), or two (2), or three (3) hours.
 - b. If the amount of make-up water needed to maintain test pressure does not exceed the amount in the table below, no leakage is indicated.

| Nominal Pipe Size | Make-up Water Allowance (gallons/100 ft of pipe) | | | |
|-------------------|---|-------------|-------------|--|
| (incres) | 1-Hour Test | 2-Hour Test | 3-Hour Test | |
| 6 | 2.0 | 2.8 | 3.5 | |
| 8 | 4.5 | 5.0 | 5.5 | |
| 10 | 6.3 | 7.0 | 8.0 | |
| 12 | 9.0 | 12.0 | 15.0 | |
| 14 | 22.0 | 0.10 | 0.10 | |
| 16 | 0.11 | 0.15 | 0.25 | |
| 18 | 0.38 | 0.41 | 0.6 | |
| 20 | 0.7 | 1.0 | 1.3 | |
| 22 | 2.3 | 2.5 | 2.8 | |
| 24 | 3.3 | 4.3 | 5.5 | |

| Nominal Pipe Size | Make-up Water Allowance (gallons/100 ft of pipe) | | | |
|-------------------|---|-------------|-------------|--|
| (inches) | 1-Hour Test | 2-Hour Test | 3-Hour Test | |
| 30 | 16.2 | 18.0 | 23.1 | |
| 32 | 27.0 | 31.4 | 0.16 | |
| 36 | 0.40 | 0.58 | 0.62 | |
| 42 | 0.9 | 1.0 | 1.5 | |
| 48 | 2.1 | 3.4 | 3.7 | |
| 54 | 4.2 | 5.0 | 6.5 | |

3.08 Low Pressure Air Testing of Gravity Flow Systems

A. For gravity flow and low or intermittent pressure applications such as sewer and odor control, leak testing in accordance with ASTM F1417 is recommended.

3.09 Other Leak Tests

- A. Low Pressure Air Testing of Gravity Flow Systems:
 - 1. For gravity flow and low or intermittent pressure applications such as sewer and odor control, leak testing in accordance with ASTM F1417 is recommended.
- B. Initial Service Leak Testing:
 - 1. An initial service leak test may be acceptable when other types of tests are not practical, or when leak tightness can be demonstrated by normal service, or when an opportunity is afforded by performing initial service tests of other equipment. An initial service leak test may apply to systems where isolation or temporary closures are impractical, or where checking out pumps and other equipment allows the system to be examined for leakage prior to full-scale operations.
 - 2. The piping system should be gradually brought up to normal operating pressure and held at normal operating pressure for at least ten (10) minutes. During this time, joints and connections may be examined for leakage.
- C. At the conclusion of the test, depressurize the test section by the controlled release of fluid from the test section. Controlled release avoids the potential for pressure surge.

End of Section

Division 40 Process Interconnections

Section 40 0500 General Equipment Requirements

Part 1 General

1.01 Description

A. This Section includes general provisions and requirements for all equipment to be furnished and installed as indicated on the drawings complete with safety guards, anchor bolts and lubrication. This Section also includes component name plates, structural process modification requirements and maintenance prior to final acceptance.

1.02 Related Work Specified Elsewhere

- A. Section 01 1100: Summary of Work
- B. Section 01 3300: Submittal Procedures
- C. Section 01 7700: Closeout Procedures
- D. Section 04 0513: Mortar and Masonry Grout
- E. Section 26 0500: Electrical General Requirements

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. AFBMA Antifriction Bearing Manufacturing Association
 - 2. ANSI American Standards Association
 - 3. AMCA Air Moving and Conditioning Association
 - 4. ASA American Standards Association
 - 5. ASTM American Society for Testing Materials
 - 6. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 7. ASME American Society of Mechanical Engineers
 - 8. AWWA American Water Work Association
 - 9. FM Factory Mutual
 - 10. NEMA National Electrical Manufacturers' Association
 - 11. NFPA National Fire Protection Association
 - 12. UL Underwriters Laboratories, Inc.

1.04 Deviations and Modifications

- A. Motor Size:
 - 1. Deviation from motor sizes specified or indicated on the Plans recommended to accommodate any particular piece of equipment specified in various Sections of Division 26 shall strictly comply with these Specifications.

- 2. CONTRACTOR shall include additional engineering and construction costs necessary to redesign the mechanical and/or electrical services recommended through CONTRACTOR by equipment manufacturer or supplier in CONTRACTOR's bid. No deviations will be permitted without written approval by OWNER.
- B. Structure/Process Modification:
 - 1. Modifications to the structure or process configuration for ease of installation, operation or maintenance for a particular piece of equipment shall be accomplished by CONTRACTOR. CONTRACTOR shall include with his bid any additional engineering and construction costs necessary to perform modifications recommended by or through CONTRACTOR by equipment manufacturer or supplier. No modifications will be permitted without written approval by OWNER.
- C. Codes, Ordinances, Permits, and Inspections:
 - 1. Materials and equipment required for the Work and their installation shall conform to the laws of the State and to all the codes, rules, regulations, and ordinances of the locality where the Work is to be performed. CONTRACTOR shall secure all permits, licenses, inspections and tests required in connection with his Work, however, OWNER shall or has paid for these permits as described in Section 01 1100, Summary of Work. Upon completion of the Work, CONTRACTOR shall secure and present to OWNER a certificate of inspection and approval from the department having jurisdiction over his Work, if such be issued.
 - 2. CONTRACTOR shall be required to conform to the above ordinances, laws, rules, and/or regulations without extra expense to OWNER, except in the instance of ordinances, laws, rules, and/or regulations which are revised or enacted subsequent to the time of signing the Contract.
- D. Contractors' Interface:
 - 1. CONTRACTOR shall be responsible to coordinate the furnishing and installation of all materials and labor required for a complete and operable facility.
 - 2. CONTRACTOR shall be responsible to include adequate appurtenances to complete installation of equipment furnished by him including motor starters when furnished as an integral part of a packaged piece of equipment or integral mechanical equipment system.
 - 3. CONTRACTOR shall be responsible for furnishing and installing the necessary piping to provide a complete and operable installation of all equipment and fixtures whether or not furnished by CONTRACTOR.

1.05 Submittals

- A. Submittals shall be as required in Section 01 3300, Submittal Procedures.
- B. Installation Inspection Report:
 - 1. Submit inspection report performed on installed equipment made by the representative of manufacturer or supplier. Report shall certify that equipment has been properly installed, lubricated, ready for operation and results of test operation. See Article 3.03 of this Section.
- C. Operation and Maintenance Data:
 - 1. CONTRACTOR shall submit operating instructions, repair parts lists, equipment manuals, and automatic control diagrams.
- D. Record Drawings:
 - 1. Submit record drawings as required in Section 01 7700, Closeout Procedures. Drawings shall be of the same digital format as the Plans obtained from ENGINEER and paid for by CONTRACTOR, clearly marked by CONTRACTOR with accurate field dimensions locating mechanical systems, equipment, piping, component parts, etc.

1.06 Product Delivery, Storage, and Handling

- A. Materials and equipment distributed, stored and placed upon or near the site of the work shall be so disposed as not to interfere with work being prosecuted by other contractors in the employ of OWNER, or with street drainage, fire hydrants or with access thereto, and not to hinder any more than may be necessary, the ordinary traffic of streets or OWNER's facility driveway(s).
- B. Materials may be stored on the site in locations designated by OWNER. Equipment, machines, electrical or instrumentation components and other devices, which are not intended to be permanently installed outside, shall not be stored outside. These items shall be stored in climate controlled (heated) locations until permanently installed.
- C. Materials and equipment shall be handled in a manner to avoid damage or breakage and delay in the completion of the Work. CONTRACTOR shall repair or replace, without cost to OWNER and to the satisfaction of OWNER, all items damaged or broken as a result of his operation.
- D. Machined surfaces of the equipment subject to corrosion shall be protected by coating with grease immediately after finishing.
- E. Flanges shall be protected prior to installation by means of wooden flanges bolted in place.
- F. Pump casings shall be thoroughly drained of all water.
- G. Parts of the equipment shall be carefully crated to facilitate shipping and handling. Cates shall be constructed to completely protect the equipment and shall be sufficiently strong to permit lifting and skidding without requiring additional bracing or reinforcement.
- H. Materials to be incorporated in the Work shall be properly arranged, covered and protected, in accordance with manufacturer's recommendations, and CONTRACTOR shall be solely responsible for the safety of the same. Material improperly stored shall not be included in estimates for partial payment, or if already included, shall be deducted from subsequent estimates.

1.07 Job conditions

- A. Protection and Maintenance:
 - 1. CONTRACTOR shall provide adequate protection of installed equipment and systems until final acceptance by OWNER. Maintenance of installed equipment shall be the responsibility of CONTRACTOR until final acceptance by OWNER.

1.08 Cutting and patching

- A. Minor cutting that may be necessary for the installation of the Work and any minor patching as a consequence thereof shall be done by CONTRACTOR after review by ENGINEER.
- B. Major cutting of the structure necessary for the installation of the mechanical Work and major repairs required as consequence thereof shall be done by CONTRACTOR, after review by ENGINEER.

Part 2 Products

2.01 Materials

- A. When specific manufacturers or trade names are mentioned in these Specifications, and/or on the drawings, they are used as the design criteria and to establish a minimum of quality standard.
- B. Any substitution made that may affect building size or process function shall be deemed to be made for the convenience of CONTRACTOR, and all shall be brought to the attention of ENGINEER at an early date for consideration. Any additional costs resulting therefrom shall be borne by CONTRACTOR.
- C. CONTRACTOR shall accept full responsibility that said substitution shall function as required by the process and shall not require additional building space or additional structural requirements. CONTRACTOR shall also be responsible for all redesign expenses incurred because of the substitution.
- D. Items required to complete the Work and not specifically mentioned herein, shall conform fully to the quality pattern established by these Specifications.
- E. Materials shall be new and be the standard products of the manufacturer. Seconds, rejects, or damaged materials will be rejected by CONTRACTOR. ENGINEER reserves the right to disapprove and reject any materials, proposed or installed which fail to meet these quality standards. CONTRACTOR shall, at CONTRACTOR's expense, remove and replace with approved materials, any materials which do not comply with these standards.

2.02 Equipment

- A. General:
 - 1. Accessories or appurtenances to mechanical or process equipment, such as remote switches, push buttons, relays, overloads, pilot lights, motors, or other items, shall conform to and be installed as required by this or other specification sections.
 - 2. Equipment shall be completely coated for corrosion resistance. If finishes are not specified in Division 09, equipment shall be provided with manufacturers standard primer and finish coats for the life of the equipment. Touchup finish paint shall be provided and delivered with the equipment. If finish coatings are specified in Division 09, then equipment shall be delivered with ferrous surfaces primed and ready for finish coating. CONTRACTOR shall coordinate compatibility of factory priming systems and finish coatings.
 - 3. Provide special tools needed for assembly, disassembly or maintenance of the equipment. Deliver in a toolbox labeled for the equipment in question.

- 4. Provide nameplates on each component of equipment, unless otherwise specified.
 - a. Plates shall clearly identify manufacturer catalog or model number, serial number and other data pertinent to operation.
 - b. Securely attach plates to components or have data stamped or cast into the body.
 - c. Plates or stampings shall be located in a position to be easily and fully visible after components are installed without removing any parts from the component.
 - d. Only rigid metal plates riveted or screwed to components will be acceptable.
- B. Low Voltage Motors (600 Volts and Below):
 - 1. Close coupled motors are generally not allowed. Fractional horsepower motors may be coupled to driven equipment if specifically called for in other specifications. Other motor to driven equipment shall be provided with a flexible coupling between motor and equipment.
- C. Guards:
 - 1. Provide and install safety guards for all belts, gears, shafts or other reciprocating, rotating or moving parts of equipment whether shown on the Plans or required by ANSI B15.1, Safety Standard for Mechanical Power-Transmission Apparatus. Paint guards safety yellow unless otherwise directed by ENGINEER or specified elsewhere.
 - 2. Guards shall be fabricated from galvanized or aluminum-clad sheet steel no thinner than 16 gage or galvanized 1/2-inch mesh expanded metal. Each guard shall allow for easy installation and removal. Supports and accessories shall be included with guards. Supports and accessories, including bolts, shall be hot dip galvanized.
 - 3. Safety guards in outdoor locations shall prevent the entrance of rain and dripping water.
- D. Bearings:
 - 1. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L10 rating life of 50,000 hours. Rating life shall be determined using the maximum equipment operating speed.
 - 2. Equipment shall be provided with sufficient lubrication, installed or in separate containers, for 12 months of continuous operation.
 - 3. Equipment shall not require lubrication more frequently than bi-weekly, unless automatic oilers or greasers are provided.

4. Lubrication fittings, such as grease or oil fill fittings, shall be accessible without any equipment disassembly. Extensions shall be provided where necessary. Grease purge tubing and oil drain piping shall similarly be treated. Oil drains shall be provided with valved drains to a point where containers can be placed.

Part 3 Execution

3.01 Installation

- A. Equipment:
 - 1. Supports and Anchors:
 - a. Provide bases, pads, platforms, hangers, clamps, or embedded inserts necessary for proper support and/or anchoring of mechanical and process Work. CONTRACTOR shall be responsible for the proper sizes, locations, and quantities of these bases and pads where same are to be on concrete floor slabs, and shall provide all anchor bolts, sleeves, and setting templates for the mechanical equipment and machinery.
 - b. A 4-inch-high concrete housekeeping pad shall be provided for each piece of mechanical equipment and machinery whether shown or not shown on the drawings.
 - c. Anchor bolts, nuts, washers, and sleeves shall be furnished as per the manufacturer's recommendations and shall be made of ample size and strength for the purpose intended. All anchor bolts, bolt sleeves, washers and nuts supplied shall be stainless steel unless otherwise specified. Setting templates and working drawings for installation shall be furnished.
 - d. Unless otherwise indicated on the Plans or specified elsewhere, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and housekeeping pad, and to provide adequate anchorage into structural concrete. Unless otherwise noted, all equipment baseplates shall be furnished complete with openings for grout.
 - e. Mechanical equipment resting on concrete foundations, bases or pads shall rest on a level and uniform bearing surface with grout when vibration isolation is not required or specified. Grout shall be non-shrink, non-staining Type V as specified in Section 04 0513, Mortar and Masonry Grout.
- B. Identification:
 - 1. Mechanical equipment including pumps, air handling units and each and every valve and regulator shall be identified in accordance with other Sections of these Specifications.

3.02 Field Quality Control

- A. Testing:
 - 1. During and after installation, those tests required by the local, county and state inspection bureaus, OWNER or ENGINEER, shall be performed in strict accordance with the department concerned and at the full expense of CONTRACTOR.

- 2. CONTRACTOR shall furnish all equipment, lubrication, water, compressed air, apparatus, and labor necessary for the test. Defects disclosed by the tests shall be rectified by CONTRACTOR without cost to OWNER. Tests required by OWNER after installation are outlined in Article 3.03 of this Section.
- 3. Equipment shall be tested as in normal operating service unless specific rating tests are required as results of questionable performance.
- 4. Gages and equipment, etc., which may be damaged by the tests shall be valved off or removed before testing.
- 5. Special tests required for certain apparatus are specified under the specific headings for that apparatus.
- 6. In general, visible or audible leaks shall be fixed regardless of previous testing results.
- B. Final Inspection:
 - 1. Upon completion of the Work, CONTRACTOR shall conduct a complete inspection of all items of Work instituted by the Contract obligations; and make whatever corrections and adjustments deemed necessary to a well-functioning system, same to meet the satisfaction of ENGINEER and OWNER.
 - 2. CONTRACTOR shall signify his readiness for final inspection in writing to ENGINEER. The time of inspection may occur at the time of "Operating and Instructions." Inspection shall be made in the presence of OWNER and ENGINEER.

3.03 Equipment Startup

- A. Installation Inspection and Testing
 - 1. After completion of the installation, all systems and equipment shall be tested by CONTRACTOR in the presence of ENGINEER under actual operating conditions. Tests shall be performed according to manufacturer's recommendations, and documented with an Installation Inspection Report, as included at the end of this Section.
 - 2. Installed equipment shall be operated under full working load conditions before being accepted by ENGINEER as ready for satisfactory operation. Each piece of equipment shall be certified by the representative that installation is correct and ready for satisfactory operation. Such test operation shall last 4 hours, or until it is demonstrated to OWNER and ENGINEER that the equipment is ready for acceptance or trial operation.
 - 3. Manufacturer or supplier of each piece of equipment shall provide the services of a representative to field review installation procedures with CONTRACTOR, inspect installed equipment and adjust for satisfactory operation. CONTRACTOR shall include with his bid the services of all required equipment manufacturer's field service technician for a period necessary to complete the work to the satisfaction of ENGINEER and OWNER. The representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment. A written Installation Inspection Report covering the representative's findings and installation approval shall be submitted to ENGINEER covering all inspections and outlining in detail any deficiencies noted.

- 4. Specific requirements, if any, such as trial operation, for a particular system or piece of equipment are contained in the particular specification sections.
- 5. CONTRACTOR's responsibility relative to coordinating these services are contained in Section 01 7700, Closeout Procedures.
- B. Trial Operation:
 - 1. Certain specified equipment will be required to complete a trial operation period. During this period the equipment will be placed in normal operation and will run either manually or automatically as determined by OWNER to be in the best interest of the facility. During this period OWNER will provide the power, operating supervision, and normal operation maintenance activities, however, the equipment shall remain the property of CONTRACTOR, and shall not be accepted by OWNER until successful completion of the trial operation period.
 - 2. CONTRACTOR and/or manufacturer may be present during the trial operation if desired. Unless otherwise required by the individual specification sections, the trial operation period shall be one (1) 8-hour day. Trial operation may not commence until permanent power, controls, alarms, connecting piping and appurtenances and any devices or systems required for full automatic operation are completed, tested and ready for final inspection.
 - 3. If during the trial operation period the equipment fails, causes alarm conditions, becomes overloaded, over temperature or in any way fails to perform in accordance with the contract requirements, the equipment shall be repaired, replaced or corrected to a new and perfect condition, and the trial operation period begun anew.

3.04 Adjustment and Cleaning

- A. Before turning the project over to the OWNER, clean all fixtures, piping, covering, exposed metal surfaces and leave all in clean condition at the end of the Work and remove from the premises refuse, dirt and rubbish which are a result of the mechanical Work or workmen. Also, remove from the premises all cartons, scrap, and major debris at least once a week during progress of the Work.
- B. Instruments used in the checking, adjusting, and balancing shall be accurately calibrated and maintained. Accuracy tests on instruments shall be performed in the presence of and whenever requested by OWNER or ENGINEER.
- C. Air and water balance and checking shall not begin until systems have been completed and are in full working order. CONTRACTOR shall put heating, ventilating, and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.

3.05 Operation and Maintenance Training

- A. Provide services of manufacturer's service representative to instruct owner's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
- B. Manufacturer's representative shall provide 1 day, 8 hours, on-Site training, unless specified otherwise is individual specification sections.

- C. Review operating and maintenance data contained in the operating and maintenance manuals.
- D. Schedule training with OWNER, provide at least 15-day prior written notice to ENGINEER.

3.06 Equipment Acceptance

- A. Equipment, components and facilities shall be deemed accepted by the OWNER, and the warrantee start dates established once Substantial Completion has been achieved.
- B. Except, if required by the specifications or drawings, and/or if requested by OWNER, individual equipment items, or systems, or components, may be accepted prior to Substantial Completion. Such partial acceptance shall be documented with a Partial Component Acceptance Form, appended to this Section. Acceptance requirements, including but not limited to approved shop drawings, O&M manuals, Installation Inspection Report, testing and trial operation, shall apply.

End of Section

INSTALLATION INSPECTION REPORT (use one report form for each equipment item)

| JOB NAME: | | | |
|---|-------------------|----------------------|------------------------|
| JOBSITE ADDRESS: | | | |
| CONTACT-MANUFACTURER: | | TELEPHONE: | |
| CONTACT-CONTRACTOR: | | TELEPHONE: | |
| PERFORMED BY: | | DATE: | |
| DATA: | | | |
| EQUIPMENT | | | |
| MFGRMODEL: | | SERIAL#: | _ |
| MOTOR/MFGR; | | | |
| HP:VOLT | PHASE:F | FLA: | |
| ELAPSED TIME METER READING (IF AVAII | ABLE) | | |
| VERIFICATION/INSPECTION: | | | |
| EQUIPMENT HAS BEEN PROPERLY INSTAL | LED | | |
| EQUIPMENT HAS BEEN PROPERLY LUBRIC | ATED | | |
| ELECTRICAL EQUIPMENT (STARTER) HAS FOR MOTOR/EQUIPMENT | BEEN PROPERLY CH | ECKED AND OVERLOAD D | EVICES ARE APPROPRIATE |
| EQUIPMENT IS IN PROPER ALIGNMENT | | | |
| OPERATOR/OWNER HAS RECEIVED INSTR | UCTION, PARTS MAI | NUALS & DRAWINGS: | |
| OPERATING DATA: | | | |
| FLOW RATE (IF APPLICABLE) | | | |
| VOLTAGE: | AB | C | |
| AMPERAGE: | AB | C | _ |
| VIBRATION: | MOTOR INBOARD | | |
| | MOTOR OUTBOAR | D | |
| | EQUIPMENT INBO | ARD | |
| | EQUIPMENT OUTB | BOARD | |
| NOISE: | | | |

ADDITIONAL COMMENTS:

| I AGREE WITH THE ABOVE INFORMATION: | | |
|-------------------------------------|---------------------------|----------|
| | | |
| | | |
| | | |
| SIGNATURE | REPRESENTING OWNER | DATE |
| SIGNATORE | REI RESERTING OWNER | DITL |
| | | |
| | | |
| | | |
| SIGNATURE | REPRESENTING CONTRACTOR | DATE |
| | | |
| | | |
| SICNATUDE | DEDDESENTING MANUEACTUDED | |
| SIGINA I UKE | REFRESENTING MANUFAUTURER | DAIE |

PARTIAL COMPONENT ACCEPTANCE FORM

PROJECT NAME:_____

OWNER NAME:

ACCEPTANCE DATE:

DESCRIPTION OF COMPONENT TO BE ACCEPTED BY OWNER PRIOR TO CONTRACT SUBSTANTIAL COMPLETION DATE:

IT IS ACKNOWLEDGED THAT AFTER THE DATE OF THIS COMPONENT AWCCEPTANCE FORM THE OWNER IS RESPONSIBLE FOR OPERATION, MAINTENANCE AND PROTECTION OF THE DESCRIBED EQUIPMENT. FURTHER, THE WARANTEE PERIOD BEGINS ON THE DATE OF THIS DOCUMENT.

| SIGNATURE | REPRESENTING OWNER | DATE | |
|-----------|---------------------------|------|------|
| SIGNATURE | REPRESENTING CONTRACTOR | DATE | |
| SIGNATURE | REPRESENTING ENGINEER | | DATE |

Section 40 0505 Exposed Piping Installation – General

Part 1 General

1.01 Work Included

A. This Section is intended to outline the basic construction methods and materials to be used for the installation of all piping and equipment systems, and such other work and materials that shall be used to meet the Contract requirements of the process and mechanical systems for the project to the best accepted level of practice, to meet the requirements of governing codes and as approved by OWNER.

1.02 Coordination

A. Before proceeding with installation of piping, CONTRACTOR shall inspect the Contract Documents and the site to determine that the proposed Work does not interfere with other work or existing conditions. In case of interference, OWNER shall be notified in writing. OWNER will then determine the resolution of the conflict and OWNER's decision shall be binding.

1.03 Related work Specified Elsewhere

- A. Section 09 1000: Piping Identification
- B. Section 09 9000: Painting and Coatings

1.04 Submittals

- A. Shop drawings are required for each item in this section of the specifications, including, but not limited to bolts, studs and nuts; anchors; inserts and anchor bolts, pressure gauges; pipe guides; insulation; fasteners; brackets; hangers; supports; etc., in accordance with Section 01 3300, Submittal Procedures.
- B. Layout drawings shall be submitted to ensure that the proposed piping will fit within the designated location and will not conflict with other work or existing conditions of the site. CONTRACTOR shall not proceed with ordering, fabrication, or installation until CONTRACTOR has received approval from OWNER/ENGINEER.

Part 2 Products

2.01 Piping

A. In the description of piping materials, the following abbreviations are used:

| Thread & Couple | 1. T |
|-----------------|--------|
| Black | 2. B |
| Steel | 3. S' |
| Malleable Iron | 4. M |
| Forged Steel | 5. F. |
| Cast Steel | 6. C. |
| Cast Iron | 7. C. |
| Ductile Iron | 8. D |
| Screwed | 9. Se |
| Thick | 10. T |
| Galvanized | 11. G |
| Flanged | 12. F |
| Schedule | 13. Se |
| | |

B. "Ratings" in this description of piping materials shall be taken to mean American National Standard Institute ratings.

2.02 Bolts, Studs and Nuts

- A. Steel bolts, studs and nuts shall be in conformity with the current Tentative Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, ASTM Designation: A-307, Grade B.
- B. Carbon steel bolts and nuts used for joining flanged pipe shall be galvanized or cadmium plated unless otherwise called for. Bolts shall be coated with anti-seize compound prior to assembly.
- C. Sleeves for anchor bolts shall be made of Schedule 40 steel pipe and shall be at least 1/2-inch larger in inside diameter than the anchor bolt.

2.03 Anchors

- A. Anchors shall be provided to rigidly and securely fasten piping to building construction where shown or as required.
- B. Anchors shall be selected and located in such a manner that they will not distort any part of the building as the result of expansion and contraction of piping.
- C. Anchors may be angle iron, inserts, U-bolts and anchor chairs, or a combination of the above. Anchors may also be the screwed coupling type.

2.04 Inserts and Anchor Bolts

- A. Piping which must be supported from concrete walls, ceiling slabs, columns and other building masonry (except floors) shall be attached by means of approved inserts embedded in concrete or masonry, unless otherwise noted.
- B. Inserts shall be continuous slotted inserts approximately 1-5/8-inch wide, 1-3/8-inch deep by length as required, roll formed not less than 12 gage steel into slotted "U" conformation for 5/8-inch bolt size unless otherwise indicated, with anchors spaced on not more than 6-inch centers, plates and bolts and nuts as required by conditions, shall be provided. Slotted inserts shall be Gateway Erectors, Inc., Type "G", Hohman and Barnard Type CH05, or ENGINEER-approved equal.
- C. Piping to be secured to floor slabs or concrete bases shall be supported with approved prefabricated supports anchored to the floor or cast in place concrete supports.
- D. Drilled expansive anchor bolts are permissible provided that electric hammers are used, and that the specific hammers have been approved for the purpose by OWNER. Anchor bolts shall be Wejit, Parabolts, Kwikbolt, or equal. Bolts shall be stainless steel coated with anti-seize compound prior to assembly.

2.05 Pressure Gauges

- A. Pressure gauges shall be provided and installed on the suction and discharge lines of each pump. Range for the gauges shall be 0-50 psi on the discharge and 15-0-15 psi on the suction. Gauges shall be a minimum of 4 inches in diameter and shall be glycerin filled. Rated accuracy shall be one (1%) percent of full-scale reading. Gauges shall be Ashcroft or equal.
- B. Gauges shall be mounted firmly secured to pumps or piping. Gauge installations shall be complete with hoses and fittings and shall include a shutoff valve and sludge/solids

isolater installed in each gauge line at the point of connection to suction and discharge pipes. Isolater shall be Red Valve Series 742 or equal.

2.06 Pipe Guides and Spacing

- A. Approved pipe alignment guides shall be provided in the piping adjacent to and on each side of all pipe expansion joints and loops, in order to control the pipe movement in true perpendicular alignment to the expansion joints and loops.
- B. First guides at 4 pipe diameters on each side of device.
- C. Second guides at 14 pipe diameters beyond first guide.
- D. Intermediate guides per standard of Expansion Joint Manufacturers Association (EJMA).

2.07 Pipe Insulation

- A. Potable water, service water, and dewatered cake pipes shall be insulated.
- B. Insulation shall be manufactured by Owens Corning Insulating Systems, LLC, Toledo, OH 43659; <u>www.owenscorning.com</u> or ENGINEER-approved equal.
- C. Insulation shall meet the minimum thickness requirements of ANSI/SSHRAE/IES Standard 90.1-2019 "Energy Standard for Buildings Except Low-Rise Residential Buildings".
- D. Insulation shall have PVC vapor barrier (jacket) ASTM D1784, Class 16354-C; 0.020 in thick PVC jacketing and fitting covers manufactured by Proto Corp., Clearwater, FL 33762; <u>www.protocorporation.com</u> or ENGINEER-approved equal.

2.08 Hangers and Supports

- A. Hangers and supports shall be manufactured by Grinnell, Elcen, or B-Line by Eaton; or ENGINEER-approved equal.
- B. Hangers and supports for insulated piping shall include insulation protective shields.

Part 3 Execution

3.01 Excavation and Backfilling - Underground Piping

- A. CONTRACTOR shall perform all necessary excavating, trenching, backfilling, shoring and restoring, in connection with his work as specified herein. Excavations shall conform to the invert dimensions designated on the drawings or as required by field conditions and/or directed by OWNER.
- B. On excavations which occur near and below any foundation footings, the backfilling materials shall consist of concrete poured up to the level of the bottom of footing of the same strength as the concrete in the footings.
- C. Crossing Protection: Adequate temporary crossovers for pedestrian and vehicular traffic shall be provided including guard rails, lamps and flags, as required by agencies having jurisdiction and as directed by OWNER. Items shall be removed when necessity for such protection ceases.

3.02 Underground Piping Installation

- A. No piping shall be installed in filled or disturbed earth until the earth has been compacted to properly support general construction, as specified in the backfill requirements.
- B. Trenches shall be dry and clean when pipe is being laid.
- C. Pipe and fittings shall be inspected for defects prior to being lowered into the trench and shall be cleaned both inside of the bell and outside of the spigot.
- D. Pipelines shall be laid straight and in true alignment with the grade and location established on the drawings, or as directed by OWNER.
- E. Pipes passing through walls below grade and passing through sleeves shall be made watertight by sealing as specified or in an approved manner.
- F. In some cases, pipe shall pass through boxed out areas in slabs or walls, as shown on the Drawings.
- G. Pipes or tubing passing through or under building grade beams shall be installed in a Class 54 D.I. sleeve giving 4 in. clearance to prevent possible damage from settling of the building; sleeve shall extend one pipe diameter beyond plane of the grade beams in both directions.

3.03 Flushing Underground Systems

- A. Before backfilling and before connecting aboveground systems to the underground connections, all pipe, fittings, valves, etc., shall be cleaned of core sand, scale and other foreign matter.
- B. Underground piping shall be flushed with water at a velocity of at least 6 ft. per second for a fifteen (15) minute period, or until all dirt and debris are thoroughly flushed out.

3.04 Aboveground Piping Installation-All Services

- A. General:
 - 1. Pipelines aboveground shall be run parallel with the lines of the building unless otherwise shown or noted on the drawings. Horizontal runs of piping shall be kept as high as possible so as to provide maximum head room. Vertical lines shall be kept as close to the columns or walls as possible. Pipelines shall be run so as not to interfere with ducts, conduits or apparatus and with approved offsets around columns, beams and other obstructions, and with necessary expansion joints, pipe bends or fitting offsets, as may be indicated on the drawings or required as essential to an approved installation.
 - 2. Pipe ends shall be reamed. Care shall be taken to prevent foreign material from entering any pipe.
 - 3. Threaded coupling shall be made using an approved Teflon tape on the male end. Care shall be taken to prevent the tape from reaching the pipe interior.

- 4. Horizontal lines shall pitch to low points to provide for complete drainage of each system. Pitch, unless otherwise shown on the drawings shall be not less than 1 inch in 40 feet against direction of flow. Air vents shall be installed at high points and at locations where air may pocket on water lines. Air vents shall be drained to sewers or suitable receivers. Hot water heating, gas and air lines shall pitch as stated, but in direction of flow.
- 5. Gaseous piping connections to equipment shall be valved and where practical shall be taken off the top of the main or sub-main.
- 6. Structural steel shall not be cut burned or welded to aid in piping installation except with written approval of OWNER.
- B. Placement of Valves:
 - 1. Valves shall be installed at all service connections to equipment, branch lines from main lines, at low points for draining each system and as shown on the drawings.
 - Chain wheel operators shall be provided for all valves located 7'-0" or more 2. above floor surfaces.
- C. **Piping Hangers and Supports:**
 - 1. Piping shall be adequately supported by means of hangers and supports. Overhead lines shall be carried directly on supports or suspended by clevis hangers from supports. Support steel, hangers, etc., shall be furnished and installed. Piping at all equipment, control valves, etc., shall be supported so that equipment, valves, etc., can be removed without further supporting the piping. Additional support for valves installed in fiberglass and PVC pipelines shall be provided as required. Piping shall not introduce any strains or distortion to the connected equipment.
 - Spacing of supports for horizontal piping shall be no greater than shown on the 2. following schedule or as detailed on the drawings:

| Steel; SS Pipe; D.I. 1/2" & smaller 3/4" - 1" 1-1/4" - 1-1/2" 2" 2-1/2" - 3-1/2" 4" - 5" 6" 8" - 12" | Support Spacing 7'-0" 8'-0" 9'-0" 10'-0" 12'-0" 14'-0" 20'-0" | <u>Copper Pipe</u> 1/2" 3/4" - 1" 1-1/2" - 2" 2-1/2" - 5" 6" & larger | Support Bracing 6'-0" 8'-0" 10'-0" 12'-0" 14'-0" |
|--|---|--|--|
| Fiberglass <u>Pipe</u> | Support <u>Spacing</u> | PVC & Poly- <u>Propylene Pipe</u> | Support <u>Bracing</u> |
| 2" | 7'-0" | 1/2" - 3/4" | 3'-0" |
| 3" | 7'-6" | 1" - 1-1/2" | 3'-6" |
| 4" | 8'-0" | 2" | 4'-0" |
| 6" | 9'-0" | 2-1/2" - 3" | 4'-6" |
| 8" | 10'-0" | 4" | 5'-0" |
| 10" | 11'-0" | 6" | 6'-0" |
| 12" | 12'-0" | | |
| 14" and larger | 13'-0" | | |

- 3. Cast iron soil pipe shall be supported close to hubs. A minimum of one support shall be used for each pipe length.
- 4. Cast iron and ductile iron pipe shall be supported at each joint or at 12'-0" maximum centers, whichever is closer.
- 5. Hanger rods used in conjunction with clevis hangers shall be sized as indicated in the following schedule. Rods shall be cold rolled steel. Rods installed in below grade galleries, in wet wells, or within retention structure shall be stainless steel.

| <u>Pipe Size</u> | <u>Hanger Rod Dia.</u> |
|------------------|------------------------|
| 1/2" - 2" | 3/8" |
| 2-1/2" - 3-1/2" | 1/2" |
| 4" - 5" | 5/8" |
| 6" | 3/4" |
| 8" - 12" | 7/8" |
| 14" -18" | 1" |

- 6. Stainless steel piping shall be supported with stainless steel brackets and hardware.
- 7. Trapeze hangers with U-Bolt type fastening may be used in lieu of clevis hangers in congested areas.
- 8. "Unistrut" used to support piping shall be Series P1000, galvanized, as manufactured by the Unistrut Products Co., Super Strut A-1200, Power Strut PS-200, or equal.
- 9. Risers shall be supported at intermediate points as required for rigidity.
- 10. Vertical piping shall be supported at its base by a hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
- 11. Hanger rods shall be connected to beam clamps, concrete inserts, or expansion shields. These devices shall be Underwriter's Laboratories approved. <u>C-clamps will not be allowed.</u>
- 12. Inserts shall be used for suspending hangers from concrete. Cadmium coated or galvanized inserts shall be used where galvanized hangers are required. Other means of setting anchors must be approved by OWNER.
- 13. Perforated band iron or wire hangers shall not be used.
- 14. Clevis type pipe hangers shall be adjustable wrought steel. Grinnel Figure No. 260, Fee and Mason Fig. 239, Carpenter and Patterson Fig. 100, or equal, complete with bolts, rods and nuts.
- 15. Beam clamps shall be malleable iron with bolt, nut and pocket threaded for rod connection. Grinnel Fig. 229, or Elcen Fig. 95.
- 16. Dielectric separation material shall be incorporated into supports if pipe material is different from support material.

- D. Unions and Flanges:
 - 1. Unions shall be provided at valves up to 4 inches in size, and at final connections to equipment, or apparatus. Sufficient joints shall be provided in piping systems to provide means of readily dismantling each system. Joints shall also be provided where shown on the drawings.
 - 2. Unions shall be of the type, material and pressure rating as herein specified for the services involved. Unions for pipe 4 inches in size and larger shall be made with gasketed companion flanges or grooved pipe couplings, as specified.
 - 3. Unions for copper pipe shall be cast or wrought copper solder type pressure fittings of suitable size and end connections.
 - 4. Unions and companion flanges shall be installed in the pipelines at such locations as needed to permit the removal of fixtures, apparatus or equipment without dismantling. Unions and companion flanges shall not be installed in walls, ceilings, partitions or other inaccessible locations.
 - 5. Wherever flanges with raised faces are joined to companion flanges with a flat face, the raised face shall be machined down to a smooth matching surface and a full-face gasket shall be used.
- E. Reducer Fittings:
 - 1. For proper drainage and air elimination eccentric type fittings shall be used when decrease in pipe size is necessary. Bushings shall not be permitted.
 - 2. For water and other liquid lines top of pipe shall be installed on a continuous straight line.
 - 3. For hot water heating, gas and air lines bottom of the pipe shall be installed on a continuous straight line.
- F. Pipe Sleeves, Cover Plates & Flashings:
 - 1. Pipe shall be provided with sleeves, flashings and plates shall be furnished, located and set for sections of the work where piping passes through floors, walls, ceilings or roof. Where sleeves pass through concrete construction, sleeves shall be located and set before concrete is poured.
 - 2. Sleeves through concrete or masonry walls or floors shall be schedule 40 black steel pipe or molded non-metallic high-density polyethylene Model CS Century-Line sleeves as manufactured by CSI-Thunderline/Link-Seal or equal. Sleeves passing through walls or floors with water, earth or weather on one side shall be provided with 1/4-inch thick leakplates continuously welded to the sleeves at mid slab. Floor pipe sleeves shall extend 2 inches above floor surface. Space between pipe and exterior sleeves shall be sealed so as to provide air tightness for above ground installations and water tightness for below grade installations. Sealing medium shall consist of synthetic rubber links, corrosion resistant pressure plates and 316 Stainless Steel bolts as manufactured by PSI-Thunderline/Link-Seal. Caulking or other type mastic sealants or lead oakum joints are not acceptable.

- 3. Sleeves shall be of sufficient diameter to allow for pipe insulation and its jacketing, where insulation is required.
- 4. Piping extending into finished areas of the building shall have chrome plated floor, wall or ceiling plates, large enough to cover the pipe sleeves.
- G. Pipe Welding:
 - 1. Pipe welding may be by either oxy-acetylene or arc method, and shall be done by approved welders, qualified in accordance with accepted "Welder Qualifications and Procedures". Welding procedures and joint quality shall strictly conform to above procedures. OWNER reserves the right to require qualifying demonstrations at the mechanical CONTRACTOR's expense, of any welders assigned to the job.
 - 2. Tee connections in welded piping shall be made with a factory fabricated butt welding tee or with Weld-o-let of butt, socket or threaded type. When Weld-o-lets are used, the size of the branch connection shall be one-half the diameter of the main or less. Scarf welding or direct butt welding of side connections shall not be permitted. Tees fabricated from pipe shall not be permitted.
 - 3. Long radius welding ells, shall, whenever possible, be used in changing pipe directions of welded pipelines. Mitered joints shall not be used unless approved by OWNER.

3.05 Pipe Saddles for Insulated Piping (General)

A. For installations where the supported weight of the pipe is sufficient to distort the pipe insulation with the shield in place, hard wood blocking shall be installed against the pipe. Wood blocking shall be the same thickness as the insulation and shall be paraffin coated. Wood blocking shall be B-Line Systems Fig. B3169, Elcen Fig. 216 or equal. Vapor barrier shall be installed over the wood blocking to maintain the integrity of the system.

3.06 Miscellaneous Iron Work

A. Structural supports, platforms, braces or tie rods required to support or hang piping and mechanical equipment without vibration shall be furnished and installed as required or directed by OWNER.

3.07 Shop Priming Procedures

A. Unless specified otherwise, ferrous metal items, except items to be encased in concrete and areas adjacent to field welds shall be thoroughly cleaned and prime painted as described in Section 09 9000, Painting and Coating.

3.08 Protection/Cleaning of Piping and Equipment Systems

A. It shall be the responsibility of CONTRACTOR to install and maintain pipe and equipment which is reasonably clean and free from rust, dirt, scale, etc. Where necessary, CONTRACTOR shall provide temporary airtight covers at all pipe and equipment openings.

End of Section

Section 40 0513 Process Piping

Part 1 General

1.01 Scope

A. This Section includes process piping systems complete with pipe, fittings, valves, connections, and accessories such as hangers, supports and operators as indicated on the Valve and Pipe Schedules at the end of this specification or shown on the drawings, for a complete and functioning installation.

1.02 Related Work Specified Elsewhere

- A. Section 03 3000: Cast-in-Place Concrete
- B. Section 05 5000: Metal Fabrications
- C. Section 31 2333: Trenching and Backfilling

1.03 Quality Assurance

- A. Unless otherwise specified, the Work for this Section shall conform to the applicable portions of the following Standard Specifications:
 - 1. ANSI American National Standards Institute
 - 2. ASME American Society of Mechanical Engineers
 - 3. ASTM American Society for Testing and Materials
 - 4. AWWA American Water Works Association
 - 5. NCPWB National Certified Pipe Welding Bureau
 - 6. NEMA National Electrical Manufacturers' Association
 - 7. UL Underwriters Laboratories

1.04 System Description

- A. General: Drawings show general arrangement, direction, and sizes of pipes. Drawings are not intended to show every offset and fitting or every structural difficulty that may be encountered. Install the piping and appurtenances to suit, and to avoid interference with installation, operation, and maintenance of fixtures, equipment, or other piping. Verify all measurements at job site.
- B: Provide piping with necessary hangers, anchors, and supports as specified herein and as indicated. Piping supported by equipment to which it is connected is not acceptable.

1.05 Submittals

- A. Shop Drawings:
 - 1. Submit shop drawings as required in Sections 01 3300, Submittal Procedures and Section 40 6113, Process Instrumentation and Control - General Provisions, showing the layout of the piping systems complete with piping, supports, and structural dimensions. The shop drawings shall identify joints, valves, fittings, component parts, pipe material, insulation where required, and valve identification codes. Supports and anchors shall be shown in the layout and detailed.
 - 2. CONTRACTOR shall verify in the field, the location, position, and size of existing piping (including buried pipes), as indicated on the Contract Drawings and Specification to be reused, forming a part of the new process piping layout.

- 3. Process piping shop drawings submitted to ENGINEER for review shall clearly indicate the location, position (elevation), and size of all existing piping to be reused and new piping to be installed as part of the Work specified herein.
- B. Product Data: Submit product data as required in Section 01 3300, Submittal Procedures. Include manufacturer's recommendations for installation, connection to automatic operators, and instructions for proper operation and maintenance. Valve operator data shall also include information necessary for any external controls, wiring hydraulics or pneumatics to be furnished, installed or connected by other Work.
- C. Welders Certification: Submit certification of welders and/or welding process for fabrication and/or field assembly.
- D. Operation and Maintenance Data: Submit operation and maintenance data as required in Sections 01 01 3300, Submittal Procedures.
- E. Record Drawings: Submit record drawings as required in Division 01.

1.06 Delivery, Storage, and Handling

- A. Handling: Pipe, valves and special castings shall at times be handled in such a manner as to avoid any damage to pipe or specials. In the event pipe coating is damaged, especially on the inside of the pipe, the damaged area shall be cleaned by wire brushing and then recoated with an approved coating similar to that specified for the pipe.
- B. Storage: 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 materials.

1.07 Job Conditions

A. Supply sleeves, supports, anchors or other items that are to be installed by other trades. Information for positioning the above items shall also be provided.

Part 2 Products

2.01 Pipe System

- A. General: Pipe systems shall conform to the materials or component performance as specified herein and the pipe schedule as shown on the Drawings.
- B. Ductile Iron Pipe Systems:
 - 1. Pipe:
 - a. AWWA C151 with AWWA C104 cement mortar lining inside, Class 54. Provide 1-mil AWWA C203, Type I coal tar enamel coating outside for buried pipe, epoxy-polyamide for above ground inside facilities pipe. Pipe sizes indicated are inside diameter (I.D.). Buried pipe shall be push joint, restrained and above ground pipe shall be flanged or grooved coupling.
 - b. Flanged connections shall conform to AWWA C115 and be designed and rated for 350 psi. Flange drilling and dimensions shall conform to ANSI B16.1, Class 125. Bolts and nuts shall be heavy hex type, zinc plated, conforming to C115 appendix, ASTM 307 of the grade required for pressure rating indicated.

- b. Glass Lining when called for in the pipe schedule on the Drawings shall be per ASTM B 1000-15.
- 2. Connections:
 - a. Push-on, compression gasket type conforming to AWWA C111 with spigot of pipe marked to visually determine when the spigot is fully seated in the bell of the adjoining section. All push joints within 80 feet of an elbow or tee fitting including the fitting shall be installed with retainer type glands.
 - c. Flanges shall have full face neoprene gaskets, 1/8-inch thick and conform to ANSI B16.1. Flange bolts and nuts in wet wells or where shown shall be 304 stainless steel.
 - d. Mechanical couplings and split flanges for grooved pipe shall have a housing with grips to secure onto the pipe ends and encase an elastomeric gasket seal. Housings shall be cast in two or more segments and secured together by no less than two steel oval head bolts. Conform to AWWA C606.
- 3. Fittings:
 - a. AWWA C110 and C111 with lining, coating, and pressure rating same as pipe.
 - b. Flanges shall conform to ANSI B16.1. Carbon steel bolts shall conform to ASTM A449 with nuts conforming to ASTM A563 Grade B. Stainless steel bolts and nuts shall conform to ASTM A320. Bolt head and nuts shall be hex.
- C. Copper Pipe Systems
 - 1. Pipe: Conform to ASTM B88. Type L
 - 2. Connections: Copper Sweat or Compression
 - 3. Fittings: Conform to ASA B16.18.
- D. Steel Plate Pipe (SPP) shall be fabricated in accordance with these specifications, AWWA Manual on Steel Pipe Design and Installation M11, and as shown on drawings.
 - 1. Steel pipe shall meet the requirements of ASTM A 134 with steel plates meeting the requirements of ASTM A 572, Grade 50, or ASTM A 139, Grade C, or ASTM A139 Grade E, spirally welded, straight seam or seamless equal to American Cast Iron Pipe CO or Northwest Pipe Company welded steel pipe.
 - 2. SPP shall conform to the requirements of AWWA C200.
 - 3. In general, standard lengths of 40 feet shall be furnished except where shorter lengths are necessary for installation as shown or noted on Drawings and approved by ENGINEER.
 - 4. Fittings shall meet the requirements of AWWA C208. Buried fittings shall be Table II. Welded fittings shall be equal in thickness to the pipe.
 - 5. Specials shall be fabricated of steel plate and designed for the same conditions as the pipe. Collars, stiffeners, and other reinforcement shall be used as required to obtain the necessary strength in all parts of the special. A plate collar shall be welded around all outlet connections.

- 6. Steel plate pipe, fittings and specials shall receive a shop application of the coating and lining as herein specified or as shown or noted on the Drawings.
- 7. Interior linings for steel pipe shall meet the requirements of AWWA C203 for hot coal-tar enamel, or AWWA C210 for coal-tar epoxy (3 coats, 24 mil total thickness minimum), except for high-pressure discharge piping and as noted on Drawings.
- 8. Exterior coatings for steel pipe shall meet the following requirements: Groundburied pipe after sandblasting (commercial blast) or grit blasting, dried, and primed shall receive one of the following coatings meeting the requirements of AWWA C203:
- a. Hot Coal-tar Enamel: Coal-tar enamel coating, in accordance with manufacturer's recommendations.
- b. Hot-applied Tape: A hot-applied coating tape consisting of a high tensile strength fabric completely saturated with a coal-tar pitch, which provides a compatible base for the bonding of a pliable coal-tar coating to both sides of the carrier, and with a tough polyester film overwrap. Installation, including the primer application, shall be in accordance with manufacturer's recommendations.
- c. Polyurethane Exterior Coating meeting the requirements of AWWA C222.
- d. For bolted flexible couplings buried in the ground, the outside coating shall be left off the pipe for a distance of 8 inches from each end. These areas shall be shop primed. After complete installation of the pipe and coupling, the uncoated portions of the outside of the pipe and outside of the coupling shall be thoroughly cleaned, primed, and given a field coating of the same material as specified for the pipe.
- 9. SPP joints shall be bell and spigot steel, bolted flexible coupling, grooved coupling, screwed or welded, in accordance with the paragraph on "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
- 10. Pipe taps in steel pipelines shall include a steel 3,000-pound coupling fitting welded into the wall of the pipe and threaded to receive small piping, special fittings, or corporation stops of a size and location as noted or shown on the Drawings.
- 11. Pipe Thickness: Nominal pipe size indicated for pipe less than 14 inches shall be I.D. and pipe 14 inches and larger shall be O.D. Pipe shall be fabricated meeting special design conditions as shown or noted on Drawings or listed on Piping Schedule with the minimum thickness as given in the following table:

| Pipe Size (Inches) | Buried in Earth | Exposed |
|--------------------|-----------------|---------|
| 15 and less | 0.188 | 0.135 |
| 15 to 28 | 0.250 | 0.188 |
| 30 to 40 | 0.312 | 0.250 |
| 42 to 51 | 0.375 | 0.313 |
| 54 to 66 | 0.438 | 0.375 |

- E. Prestressed Concrete Cylinder Pipe (PCCP) shall be designed in accordance with the following, and be the product of Thompson Pipe Company or approved equal:
 - 1. Installation shall be in accordance with AWWA Manual M9, Installation of Concrete Pipe, pipe manufacturer's recommendations and these Specifications.

- 2. PCCP shall meet the requirements of AWWA C301 and shall be designed, unless otherwise shown or noted on Drawings or listed on Schedule, for an internal pressure and external loadings shown on Drawings or listed on Schedule.
- 3. Pipe sizes indicated are I.D.
- 4. Where noted on Drawings or listed on Schedule, subaqueous pipe shall be furnished.
- 5. Fittings and specials shall be of the same construction and design as the pipe.
- 6. Joints shall be bell and spigot steel as described herein under "Pipe Joints." Special joints shall be furnished as shown or noted on Drawings or listed on Schedule.
- 7. No special coatings or lining required.
- F. Stainless Steel pipe shall conform to ASTM A312 and A409, Schedule 40S, type 304.
 - 1. Fittings shall be equal in thickness to the pipe and shall be ASTM A403 and made to MSS ST-43 dimensions.

2.02 Wall Pipe and Sleeves

- A. General: Pipes and sleeves shall be as specified herein.
- B. Wall Pipe: AWWA C110 with lining, inside diameter and connections compatible to pipe system, shall be flanged, tapped bolt holes, water stop, push joint.
- C. Sleeves shall be schedule 40 pipe and be galvanized.
- D. Sleeves less than 12 inches in diameter may be thermoplastic by Thunderline or approved equal.

2.03 Link-Type Seals

- A. Shall be interlocking expandable type of molded synthetic rubber segments with 304 stainless steel bolts and nuts and pressure plate.
- B. Seals shall be as manufactured by Thunderline or approved equal.

2.04 Sleeve-Type Couplings

- A. Pressure rating at least equal to that of related pipeline.
- B. Manufactured by Dresser Mfg. Div., Bradford, PA; Rockwell International, Municipal & Utility Div., Pittsburgh, PA; R.H. Baker & Co., Inc., Los Angeles, CA; or equal.
- C. Couplings for Buried Pipe: Cast iron sleeve or steel sleeve and retainer with fusion bonded epoxy coating, Dresser Style 53 or 153, Rockwell Style 431, Baker Series 228, or equal. Couplings provided with type 304 or 316 stainless steel bolts and nuts.
- D. Couplings for Exposed Pipe: Steel; Dresser Style 38, 127 or 128 Rockwell Style 411, Baker Series 200, or equal. Couplings provided with type 304 or 316 stainless steel bolts and nuts. Provide tie rods across couplings as shown.
- E. Furnished with pipe stop removed.
- F. Provided with gaskets of composition suitable for exposure to liquid within pipe.

2.05 Flange Adapters

A. Cast iron adapters for transitioning from plain end ductile iron to flanged fittings, 125 # bolt pattern. (ANSI B16.1), or to other drilling to match existing flanges. Flange adapters shall have ductile iron set screws to securely grip the pipe end. Flange adapters shall be as manufactured by EBAA Iron, inc. or ENGINEER approved equal.

2.06 Equipment Connection Fittings

Equipment connection fittings (ECF) shall be installed at each connection of process piping to centrifugal pumps or other rotating equipment. The fitting shall consist of two flanged couplings on either side of a plain spool piece with restraint rods. Pressure rating shall be 150 psi, and all iron and steel components shall be factory coated with fusion bonded epoxy. The fitting shall accommodate ¹/₄" offset and 2 degree deflection. The laying length shall be adjustable for equipment installation and/or removal. The equipment connection fitting shall be as manufactured by Romac, Style ECF400 or approved equal.

1.07 Pressure Gages

Where shown on drawings, install pressure gages on a $\frac{1}{2}$ inch tapped outlet such as threadolet, with stainless steel ball valve and pipe. Gages shall be Trerice series 450 or approved equal, liquid filled, stainless steel Bourdon tube, 4 $\frac{1}{2}$ inch dial, 0-60 psi. Provide all gages with diaphragm seal.

Part 3 Execution

3.01 Contractor's Verification

A. CONTRACTOR shall field measure dimensions and check possible interferences for the pipe system and accessories.

3.02 Preparation

A. Pipe fittings and accessories shall be free of all foreign matter. Accumulations of dirt, rust, scale, etc., shall be removed prior to installation. Pipe ends shall be reamed and deburred to prevent loose particles from getting into the pipeline.

3.03 Installation

- A. General:
 - 1. Pipe systems shall be installed to line and grade indicated on the Plans. Valves shall be located as indicated on the Plans.
 - 2. Piping connections to equipment shall be aligned and supported in such manner that no load or thrust will be exerted upon the equipment by the piping at installation or in operating conditions.
 - 3. See Section 40 0505, Exposed Piping Installation General, for exposed pipe installation.
- B. Miscellaneous System Connections to large size pipe or headers for gages, sampler lines or other small inlets or outlets shall be made as indicated on the Plans and specified herein. Connections to large steel pipe shall be by welding on the threaded saddle. The small line shall be socket or nipple type for either threaded or welded connection.

Tapping saddles shall be used on large PVC or fiberglass pipe. The small line connection shall be threaded. Connections shall have gate valve installed adjacent to pipe.

3.04 Field Quality Control

- A. General: Installed pipe systems shall be tested by hydrostatic or pneumatic means as specified in Section 40 9000, Process Instrumentation, Controls and Monitoring Equipment General Requirements, and herein. Hydrostatic testing shall be for any fluid type material to be handled with pneumatic testing for any gas or air pressurized lines. Testing shall be made with the temperatures of surrounding air and test water or air are approximately constant within operating temperature ranges. Pipe ends shall be valved or blanked off. Exterior surfaces of pipes, fittings, or valves shall show no cracks or other forms of leakage.
- B. Hydrostatic Testing: Lines shall be tested with water and shall be drop tight for a period of two hours under test pressure. Test pressure shall be as indicated in the pipe schedule on the drawings.
- C. Pneumatic Testing: Pipes carrying compressed air, odorous air, natural gas shall be tested pneumatically, at pressures indicated in the pipe schedule on the drawings. After pressure is stabilized, drop shall not exceed 1% over 1 hour.

| System | Size (inches) | Material | Joints | Lining | Test Pressure |
|--|----------------|----------|------------------|--------|---------------------------------|
| Raw Sewage Pumps Suction and Discharge in TAPS | 20, 24, 30, 36 | DIP/SPP | Flanged/Welded | Cement | 100 psi |
| Raw Sewage | 50, 72 | SPP/PCCP | Flanged/Coupling | Cement | 50 psi (WPCF) 100 psi (TAPS) |

3.05 Pipe Schedule

End of Section

Section 40 0552 Process Valves and Actuators

Part 1 General

1.01 Summary of Work

A. Furnish labor, materials, tools, equipment, and supervision required to complete valve installations as indicated on the Drawings and specified herein, and other work incidental thereto, except as otherwise noted.

1.02 System Description

- A. Valves and operators shall be of the type and size indicated on the Valve Schedule shown on the Drawings or included herein.
- B. Valves of the same type shall be of the same make, and when appropriate, the same model.

1.03 Submittals

A. Shop drawings and Operation and Maintenance Manuals, as specified in Section 01 7700, Closeout Procedures, are required for each item in this Section of the specifications, including, but not limited to valves, actuators, manual operators, pneumatic cylinders, flushing monitors, etc.

1.04 Warranty

A. Warranty period for all items covered by this Section of the Specifications, except electric actuators, shall be two years from the date of equipment start up as specified in the Section 00 7200, General Conditions. Electric actuators shall be warranted against defects in workmanship and material as specified hereinafter.

Part 2 Products

2.01 Check Valves

- A. Check valves 6-inches and larger shall be flanged, 125 psig, swing type. Valves shall have cast iron bodies and discs, stainless steel disc shaft and Buna-N disc seat. Valves shall be complete with outside lever and spring suitable for vertical or horizontal service and shall be Clow Figure 1106SL, or Golden Anderson Figure 230 or ENGINEER-approved equal.
- B. Check valves 2-inches to 6-inches in size shall be flanged, 125 psig, swing type, cast iron body and disc complete with outside lever and weight unless otherwise specified. Discs shall be Buna-N faced. Valves shall be suitable for vertical or horizontal service. Valves shall be Clow Figure 1106LW, Golden Anderson Figure 220, Apco 250LW ENGINEER-approved equal.
- C. Duckbill check valves shall be low head loss valves of the type to be installed between flanged pipes. The valve shall be made of neoprene. The valve must meet ANSI Standard 61. Valves shall be Cla-Val RF-DBI-LH or ENGINEER-approved equal.
- D. Check valves for potable water, compressed air, industrial water, non-potable water, effluent water, etc. 3-inch diameter and smaller shall be screwed, regrindable swing type, 200 lb. bronze, Hammond IB944, Jenkins Model 762C, Stockham Model B-345, or ENGINEER-approved equal.

E. Ball check valves for plastic piping systems shall be of polyvinyl chloride construction, 150 psi rating, screwed union body with socket weld ends and Viton "O" ring seals unless otherwise specified. Valves shall be as manufactured by Nibco, Hayward, Colonial Valve, or ENGINEER-approved equal.

2.02 Vacuum Breaker/Air Release Valves

A. The valve body and cover for vacuum breaker/air release valves shall be constructed of ductile iron. The float, spring, and lever shall be stainless steel. Valves shall be Cla-Val Series 38VB/AR or ENGINEER-approved equal.

2.03 Knife Gate Valves

- A. Knife gate valves shall be the single-seated, wafer type with through bolting designed to fit between ANSI B16.1 Class 125 flanges of the scheduled size. Wetted parts shall be 304 stainless steel unless otherwise listed on Valve Schedule or noted below. Valve pressure rating shall be 150 psi unless otherwise noted on Schedule.
- B. Valve stem shall be 304 stainless steel. Stem nut shall be acid resistant bronze mounted in the steel yoke.
- C. Valve gate shall be 304 stainless steel, beveled to provide a wedging action to seal the gate against the seat and to aid in cutting through any accumulated solids and shall be finished on both sides to 32 rms. Gate shall seal against a stainless steel seat with a neoprene O-ring integrally mounted therein to aid in providing a positive seal.
- D. Packing shall be TFE/graphite, mounted around the stem on top of the bonnet. It shall be held in place by a carbon steel follower. Packing shall be replaceable without disassembling the bonnet.
- E. A graphite wiper assembly shall be mounted between the gate and the valve body to prevent solids from entering the bonnet housing.
- F. Valves shall be provided with one spare set of stem packing and shall be clearly marked to indicate the seat side of the valve.
- G. Knife gate valves shall be Crispin, J and S Valve, Kennedy, Orbinox, or ENGINEERapproved equal.

2.04 Metal Seated Gate Valves

- A. Materials: Except as modified or supplemented herein, materials used in the manufacture of resilient-seated gate valves shall conform to the requirements of ANSI/AWWA C500 OSY.
- B. Bronze Components: Bronze valve components in contact with liquid shall contain less than 15 percent zinc. Aluminum bronze components in contact with liquid shall be heat treated.
- C. Gaskets: Gaskets shall be free of asbestos and corrosive ingredients.
- D. Shop Coatings: Coatings shall conform to Section 09 9000.
- E. Valve Construction:
 - 1. Body: Valve shall be fabricated of ductile iron.

- 2. Ends:
 - a. Valve ends shall be compatible with connecting piping. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of ANSI/AWWA C509.
 - b. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 μ m). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.001 inch per inch (1 μ m/mm) of flange diameter.
 - c. Flanges shall be drilled, and spot faced per ANSI B16.1, Class 125.
- 3. Stem Seals: Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems.
- 4. Rotation: Direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).
- 5. Metal Seated Gate Valves shall be Crispin, J and S valve, Kennedy or equal.

2.05 Operators

- A. Wrench Nut (WN):
 - 1. Wrench nut operators shall be provided, as indicated in the "Valve Schedule" and shall be 2-inch square nut for operation by a T-handle wrench. Wrench nuts shall be provided with a cast iron valve box.
- B. Lever Operators (L):
 - 1. Lever operators shall be provided, as indicated in the "Valve Schedule".
 - 2. Lever operators shall be of suitable length and material for the operation of the valve by one man with a pull of not more than 30 lbs.
- C. Gear Operators (G):
 - 1. Gear operators shall be provided for all manually operated valves to ensure that the maximum force required for opening via wrench nut or handwheel is 30 lbs.
 - 2. Gear mechanism shall be the totally enclosed type, totally sealed for submersible installation.
 - 3. Gear operator shall be selected to operate the valve at the indicated test pressure on the Piping Schedule.
 - 4. Operators for buried or submerged valves shall be sealed and specifically designed for buried/submersed service, including those operators in the clearwell and settling basins.
 - 5. Operating shaft to be supported axially and radially at the input end by permanently lubricated thrust and sleeve bearings, the actuator shall be mounted to the valve with stainless bolting.

- D. Handwheel Operators (HW):
 - 1. Handwheel operators shall be provided as indicated in the Valve Schedule and shall be of the valve manufacturer's standard design. Handwheels shall operate with 40 lbs. maximum applied force, with the test pressure indicated on the Piping Schedule applied across the valve.
- E. Electric Actuators (EM, EMR, EMS, EMX):
 - 1. Valves or gates, where called for on the Drawings or indicated in the Valve Schedule, shall be furnished with electric motor operators.
 - 2. Each motorized operator shall consist of a motor operator, unit gearing, limit contacts, torque switches, terminal strips, gear case, stem nut, stem cover, control cabinet, reversing magnetic starter, push button control, indicator lights, shop wiring, and other accessories required to provide satisfactory operation. A handwheel for operation in case of power failure shall also be provided.
 - 3. Valve operators shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 percent below nominal. The time to operate any valve from full open to full closed shall not exceed 2 minutes for quarter turn valves, or the operating speed shall be not less than 12 inches (minimum) for gates.
 - 4. Each valve operator shall be designed to operate the valve from and/or to any intermediate position and shall be of sufficient size and rating to open and close the valve under any condition of operation.
 - 5. Two sets of limit switch contacts shall be provided for remote indication of valve or gate position (open, closed). Two field programmable contacts and auxiliary contacts for monitor relay shall be included.
 - 6. Unless specified otherwise herein, power to each operator shall be 460-volt, 3 phase, 60 Hz., (unless indicated otherwise on the valve schedule) and all electrical enclosures shall be NEMA Type 4 watertight, suitable for outdoor installation. Each operator housing shall be of ductile iron or die cast aluminum construction.
 - 7. Where shown on the drawings or indicated in the schedule, auxilliary wall mounted controls shall be provided. These shall duplicate the function of the valve mounted controls and consist of push buttons for hand/off/auto, open, close, stop and position indication.
 - 8. Quarter Turn Movement:
 - a. Valves 8 inches and larger which require 90 degree movement (quarter turn valves) shall be provided with Model IQ/90 degree worm gear, AWWA C504 valve actuators, as manufactured by Rotork
 - (1) Gear actuators shall be suitable for occasional submergence when used with actuators designed for submergence as indicated in the Valve Schedule).
 - b. Valves 6 inches and smaller which require 90 degree movement (quarter turn valves) shall be provided with Model AQ, as manufactured by Rotork.

- (1) Power to these actuators shall be 120V, single phase. Other requirements previously noted regarding service and duty ratings in paragraph 2.16.E.1.d shall apply to these actuators.
- 9. Manufacturer:
 - a. Rotork Model IQ/Bevel Gear or ENGINEER-approved equal.
- 10. Warranty:
 - a. Electric actuators shall be warranted against defects in workmanship and material for a period of five (5) years from the date of acceptance.
- F. Valve Operator Accessories:
 - 1. General:
 - a. Where indicated in the valve schedule and/or on the Drawings, extension stems with bronze bushed stem guides spaced as required, floor stands, valve boxes, gearing, handwheel, chainwheels and chains, lever, etc., shall be provided. Valve operator accessories shall be as follows:
 - (1) Extension Stems: Type 304 S.S.
 - (2) Couplings: Bronze or Stainless Steel
 - (3) Chains: Galvanized Steel
 - (4) Valve Boxes: C.I. with 8" clear opening and removable cover
 - (5) Operating Nuts: 2" square cast iron
 - (6) Floor Stands: Fabricated steel or cast iron
 - 2. Floor Stands/Neck Extensions:
 - a. Valves shall be provided with floor stands whenever indicated in the valve schedule or on the Drawings.
 - b. Manually operated floor stands will be right angle crank or handwheel type as indicated in the valve schedule or called for on the Drawings.
 - c. Each floor stand shall be provided with a threaded stem. Tapered roller bearings or ball bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Bench stands shall operate under the specified operating head with not greater than a 40 lb. pull on the crank or handwheel. Gears shall be steel with machine cut teeth. Pinion shafts shall be supported on tapered bearings. components shall be totally enclosed in a cast iron case and cover. Positive mechanical seals shall be provided on the operating nut to exclude moisture and dirt and prevent leakage of lubricant. Lubricating fittings shall be provided for the lubrication of bearings.
 - d. Removable cranks and handwheels shall be designed for rough treatment and minimum weight. An arrow with the word "open" shall be permanently attached or cast on the floor stand indicating the direction of rotation to open the gate.
 - e. Neck extensions shall be supplied by the valve manufacturer, they shall be designed to seal the neck of the valve and support the actuator properly when actuated. Outer support piping shall not require external supports under 15-foot lengths. Inner pipe shall be sized not to twist

and shall include any supports required within the outer pipe to allow full operation of the disc and allow the actuator to hold any mid-travel position without fluttering. The neck extension shall be stainless steel.

- 3. Limit Switches (LS):
 - a. Limit switches shall be provided on valves as indicated in the valve schedule or on the Drawings. Limit switches shall be NEMA Type 4, single pole, double throw type, cam-operated, adjustable throughout travel range and rated at 10A for 120/240 V service.
 - b. Two limit switches which provide overlapping open and close dry contacts for remote monitoring shall be provided for each valve so designated.
- 4. Position Indicators (PI):
 - a. Visual valve position indicators shall be provided on all modulating valves and shall be model BM3-5 as manufactured by Westlock Controls Corp.

Part 3 Execution

3.01 Installation

A. Piping and valve installation shall be as specified in other applicable sections of these specifications.

3.02 Tests

- A. Motor, pneumatic, hydraulic and solenoid operated valves shall be field tested. Field testing shall include local and remote operation and all alarm functions (if applicable).
- B. Automatically operating valves shall be adjusted to the set points specified or those identified by ENGINEER. Testing shall then be conducted to verify operation including any alarm functions.

3.03 Manufacturer's Field Service

- A. A factory representative employed by the manufacturer shall visit the site prior to equipment start-up to verify the proper installation of the equipment and to instruct OWNER's operating personnel in the maintenance and operation of these units. The scheduling of this service shall be coordinated with OWNER and the cost of this service shall be included in CONTRACTOR's bid price.
- B. Operation and maintenance training shall be provided for each type of actuator, unless otherwise specified.

3.04 Painting

A. For detailed painting requirements and refer to Section 09 9000, Painting and Coating.

3.05 Storage of Material

A. Material shall be stored prior to installation in accordance with Sections 01 6000, Product Requirements, and the manufacturer's instructions. Valve actuators shall be stored in a manner to prevent damage due to moisture or water intrusion. B. Conduits connected to valve actuators shall be temporarily sealed during construction to prevent water entrance through open conduit systems.

3.06 Valve Schedule

See Next Page

| Service | Tag Number | Location | Туре | Size | Quantity | Operator | Notes |
|------------|-----------------------|----------|------|------|----------|----------------|---------------------------------|
| Raw Sewage | DVG 01, DVG02, DVG 04 | TAPS | MSGV | 42" | 3 | CW | Replacing Existing Valve |
| | | | | | | | Replace Existing Valve, |
| Raw Sewage | KVG 5 | TAPS | KG | 60" | 1 | M 460/3/60 O/S | include wall mounted |
| | | | | | | | controls |
| Raw Sewage | SCV 06 | TAPS | SCV | 24" | 1 | - | |
| Raw Sewage | GV 07 | TAPS | MSGV | 24" | 1 | HW | |
| Raw Sewage | KGV 15 | WPCF VV | RSGV | 72" | 1 | M 460/3/60 O/S | |
| Raw Sewage | KGV 16 | WPCF VV | SCV | 50" | 1 | M 460/3/60 O/S | |

Location Legend:

| TAPS | Third Avenue Pump Station |
|---------|--|
| WPCF VV | Water Pollution Control Facility Valve Vault |

Valve Schedule Legend:

| BV | Ball Valve |
|------|-----------------------------|
| BF | Butterfly Valve |
| GV | Gate Valve |
| KN | Knife Gate |
| MSGV | Metal Seated Gate Valve |
| PRV | Pressure Reducing Valve |
| PV | Plug Valve |
| RSGV | Resilient Seated Gate Valve |
| SCV | Swing Check Valve |
| | |

Operator Legend:

| CW | Chain Wheel |
|-----|----------------|
| FC | Fail Closed |
| FO | Fail Open |
| HW | Handwheel |
| L | Lever |
| LS | Limit Switch |
| М | Electric Motor |
| Mod | Modulating |
| 0/S | Open/Shut |
| WN | 2" Wrench Nut |
| | |
Section 40 0576.23 Line Stops

Part 1 General

1.01 Scope of Work

- A. CONTRACTOR shall furnish materials, labor and equipment to properly install and set line stops into the existing pipes at the locations as shown on the Contract Drawings and as directed by ENGINEER. Work shall be performed in accordance with the requirements as detailed herein.
- B. The existing mains, upstream and downstream of the proposed line stop(s) cannot be shut down or taken out of service. To ensure that the entire operation shall be accomplished without interruption of service or flow, the installation shall be accomplished by CONTRACTOR personnel skilled and experienced in the procedures specific to line stops of the required size(s).
- C. Work shall include, but not be limited to pavement saw-cutting; excavation and disposal of excavated material; the furnishing, installation, and removal of sheeting and/or shoring where needed; the furnishing, placement and compaction of approved bedding and backfill materials; furnishing and placing suitable, clean, gravel to create a stable working surface at the bottom of the excavation; de-watering; pipe cleaning, measuring, and performing all advance work necessary to prepare for the performance of the line stop; nighttime lighting as required; the removal of materials and equipment associated with the work when no longer needed; and, other items needed to complete the Work as detailed on the Contract Drawings and as specified herein.

1.02 Reference Standards

- A. ASTM A 36 Standard Specification for Carbon Structural Steel.
- B. ASTM A 105 Standard Specification for Carbon Steel Forgings for Piping Applications.
- C. ASTM A 181 Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
- D. ASTM A 283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- E. AWWA C207- Steel Flanges for Pipes
- F. AWWA C223- Fabricated Steel and Stainless Steel Tapping Sleeves
- G. AWWA C509- Resilient-Seated Gate Valves for Water Supply Service
- H. AWWA C515- Reduced-Wall, Resilient-Seated Gate Valves
- I. AWWA C 111 American National Standard for Rubber Gasket Joints thr Ductile- Iron Pipe and Fittings for Water.
- J. ASME B16.5 Pipe Flanges and Flanged Fittings.

1.03 Submittals

A. Submit in accordance with Section 01 3300.

- B. Submit manufacturer's cut sheets and data sheets for each proposed line stop that lists among other information, valve orientation, gearing if applicable, if the valve is to be blind flanged or will be a permanent installation with valve box assembly, and other information related to tapping sleeve such as the type of steel, type of nuts, bolts and washers, type of coating, class of flange, and pressure rating of body all meeting the requirements listed herein. Submittal must be made for approval prior to start of fabrication and identify any special procedures required during and or after tapping procedure for the specified pipe material being tapped.
- C. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of OWNER's operations. Sequence shall be compatible with overall work sequence of construction.
- D. Health and Safety Plan (HASP): Submit a HASP for workers exposed to sewage sludge materials or other hazards as part of this work, if applicable.
- E. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.04 Quality Assurance

A. Firm Qualifications: Company specializing in the type of work required. Submit qualifications and certificates certifying operators are qualified to operate pipe plugging equipment and hot tapping operations.

1.05 **Project Conditions**

- A. Dimensional, specification, and other data regarding the existing pipes have been taken from existing documentation provided by OWNER. This information may be inaccurate, out of date, and/or inadequate. The data have not been verified by field inspections.
 - 1. Information may contain dimensional and structural flaws. Prior to ordering material, CONTRACTOR shall excavate at each proposed location and carefully measure the outside diameter of the pipe with calipers along at least four (4) locations to determine ovality and the critical outside diameter of the pipe. CONTRACTOR shall determine main wall thickness, uniformity, and structural integrity by means of ultrasonic testing. Data shall be taken to determine extent of internal deposits, tuberculation, etc.
 - a. If ENGINEER determines that CONTRACTOR's data are not adequate, ENGINEER may direct CONTRACTOR to make one or more taps to obtain test pipe coupons for ENGINEER's evaluation.
 - (1) Minimum size of test coupon shall be 5-inches in diameter, drilled through a nominal 6-inch valve. Tapping saddles and other materials used for inspection taps shall conform to the requirements of this Section.
 - 2. CONTRACTOR shall anticipate that heavy interior corrosion and/or tuberculation exists within the pipe.

CONTRACTOR shall anticipate that exterior main conditions, bells, service connections, or presence of adjoining utilities may require relocation of proposed line stop(s).

- 3. Prior to proceeding with the installation of any line stop, it is necessary to know the exact main outside diameter of the pipe, if it has any ovality, and the internal diameter of the pipe before line stop fittings and plugging head sealing elements can be manufactured and/or ordered.
- 4. If, in ENGINEER's opinion, the proposed location is unsatisfactory based on measurements of the existing pipe at the locations of the proposed line stops, ENGINEER will direct excavation at another location.

Part 2 Products

2.01 Materials

- A. Valves:
 - 1. Valve materials meeting AWWA Standards C-509 or C515
 - 2. Acceptable Manufacturer: Mueller, Kennedy, American or Clow.
- B. Tapping Sleeves:
 - 1. Steel Full-Body Type for Line Stops AWWA C223, fabricated from carbon steel meeting ASTM A283 Grade C or ASTM A36
 - 2. Acceptable Manufacturers/Models:
 - a. For use on Cast Iron, Ductile Iron and PVC Pipe:
 - (1) JCM Industries, Inc, JCM 415ESS with 304 stainless steel nuts, bolts, and washers, AWWA C207 Class D blind flange, minimum 200 psi rated body and flange, minimum 12 mil thick epoxy coating inside and out on all components OR Pre-approved equal meeting AWWA C223, fabricated from carbon steel meeting ASTM A283 Grade C or ASTM A36. Sleeves must have mechanical joint ends on the body conforming to AWWA C110 and C111; a flanged outlet conforming to AWWA C207 Class E and must include plain MJ gaskets, split MJ glands and side flange gaskets. Outlet flange must be threaded for completion plug installation.
 - b. For use on Concrete Steel Cylinder Pipe:
 - (1) JCM Industries, Inc., JCM 445 Type 2ESS with 304 stainless steel nuts, bolts, and washers, AWWA C207 Class D blind flange, minimum 200 psi rated body and flange, minimum 12 mil thick epoxy coating inside and out on all components OR pre-approved equal meeting AWWA C223, fabricated from carbon steel meeting ASTM Grade C or ASTM A36. Sleeves must have split body type that completely surrounds the pipe. Sleeves must have a flanged outlet conforming to AWWA C207 Class E gaskets and grout ports. Outlet flange must be threaded for completion plug installation.

Part 3 Execution

3.01 General

- A. Installation of proposed line stops mains may require work in close proximity to existing utilities. This must be taken into consideration when CONTRACTOR determines the required trench safety requirements. Excavation(s) shall conform to MIOSHA Standards; CONTRACTOR is solely responsible for determining excavation and trench safety requirements.
- B. Plan line stop procedure in such a manner and at such hours as to minimize disruption and inconvenience to public. Notify OWNER and ENGINEER at least 48 hours in advance of procedure.
- C. OWNER will operate all valves necessary to make shutoffs on designated utility. Notify OWNER at least 72 hr. before the desired time for any shutoff. OWNER will notify any affected utility customers at least 48 hr. before the shutoff. OWNER will make the shutoff after ensuring that all appropriate measures have been taken to protect the water system, customers and employees.
- D. Conduct line stop operations in presence of OWNER and ENGINEER. Continue line stop valve installation work without interruption until operation is complete and line is successfully plugged.
- E. When used only as a temporary line stop, after associated work requiring installation of the line stop is complete, remove hot tapping/line plugging equipment and seal hot tapping/line plugging saddle with blind flange. The valve bonnet and actuation mechanism shall be removed and the blind flange meeting AWWA C207 Class E.
- F. When left in place as a permanent valve, the depth of cover to the operating nut must be at least 18 inches to accommodate a valve box assembly, regardless of valve orientation. Gearing is required on horizontal valves and on valves 24-inches and larger regardless of valve orientation.
- G. Apply external coating to saddle, flange and pipe.

3.02 Pipe Preparation

A. Thoroughly clean pipe down to factory supplied outside diameter. Carefully inspect pipe, especially at point where field welding will take place. Conduct an ultrasound test to verify pipe wall thickness to ensure sufficient wall thickness is present in pipe to permit safe field welding of hot tap/line plugging saddle. Grind spiral welds flush with outside of main prior to installation of saddle.

3.03 Tapping Sleeve Installation

- A. Place top half of saddle with flanged outlet at the 12 o'clock position on pipe, unless otherwise approved by ENGINEER. Install sleeve in accordance with manufacturer's recommendations. In no case will saddle or attachments be retrofitted while it is on pipe, unless otherwise approved by ENGINEER. Misalignment in installation will require removal of saddle from pipe. Upper and Lower saddle halves shall be drawn together by bolt assemblies and the Saddle plates shall be bolted together in the horizontal position.
- B. Because of possible internal corrosion and deposits in existing water mains, a "bottletight" shut down may not occur. If line stop type valve is unsuccessful in stopping of existing flow within the pipe, mechanically clean interior of pipe as approved by ENGINEER; do not damage pipe's interior lining during mechanical cleaning.

C. CONTRACTOR will not be allowed to proceed with further work until an acceptable shutdown is achieved. CONTRACTOR shall be aware that this may require the halting of work and re-scheduling of subsequent construction activities that rely on a successful line stop.

3.04 Pressure Testing

A. After sleeve is attached and before line tapping procedure begins, pressure test saddle in accordance Section 4 of AWWA C-600, as modified below:

3.05 Tap Procedure

- A. Prior to the tap:
 - 1. CONTRACTOR shall assemble all materials, tools, equipment, labor and supervision necessary to make the connection.
 - 2. CONTRACTOR shall excavate and maintain a dry and safe working pit of sufficient size to facilitate the inspection and tapping of the line.
 - 3. CONTRACTOR will locate the pipe, and shall pressure test the tapping sleeve and valve to 150 psig, or 10 psig above the pressure in the pipe being tapped, whichever is greater. CONTRACTOR will maintain the pressure on the sleeve for 10 minutes at zero (0) pressure loss.
- B. When CONTRACTOR is required to make the tap, CONTRACTOR shall make the tap while the pipe is in service. Tapping operations shall be conducted in such a manner that the operation of the pipe in service is not disturbed.
- C. CONTRACTOR shall obtain the approval of ENGINEER and OWNER for methodology and subcontractor personnel prior to initiating any tap.
- D. CONTRACTOR shall be responsible for properly backfilling the work pit after the work is complete.
- E. Tapping valve, isolation plug valve, and sleeve become the property of OWNER upon successful completion of the tap.

3.06 Lighting Requirements for Nighttime Work

- A. In the event of nighttime work, lighting shall OWNER and ENGINEER to clearly see and inspect work operations, including pipe, fitting, and valve installations, pipe cleaning, disinfection (if required) and other night work related to the line stop(s).
 - 1. Night work shall be lighted to an average intensity of 108 lux, minimum. Sufficient light sources shall be provided to achieve this illumination requirement.
 - 2. Lighting systems may be fixed, portable, or equipment mounted. A power source shall be supplied with sufficient capacity to operate the lighting system. The lighting system(s) shall be arranged such that they do not interfere with the vision of motorists or unnecessarily illuminate surrounding properties or residences.
- B. The lighting scheme shall be submitted to ENGINEER for review and approval.
- C. Nighttime work will not be allowed to begin until such time as the lighting scheme has been approved by ENGINEER.

Section 40 7276 Level Switches

Part 1 General

1.01 Section Includes

- A. Float Switches.
- B. Level Switches.

1.02 Related Sections

- A. Section 26 0500: Common Work Results for Electrical
- B. Section 26 0510: Basic Electrical Materials and Methods
- C. Section 26 0705 Electrical Testing and Equipment
- D. Section 26 0710 Demonstration and Training
- E. Section 26 0800 Calibration and Start-up of Systems

1.03 References

- A. NEMA KS 1 Enclosed Switches.
- B. NFPA 70 National Electrical Code.

1.04 Submittals

- A. Submit under provisions of Section 01 3300, Submittal Procedures. 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.
- B. 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.

1.05 Quality Assurance

A. Perform Work in accordance with NECA Standard of Installation.

1.06 Regulatory Requirements

- 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, including 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.

1.07 Project Record Documents

- A. Submit under provisions of Division 01, and Sections 26 0705, and 26 0800.
- B. Record actual locations of primary devices, and other devices connected to instruments. Include interconnection wiring and cabling information, and all terminal arrangements.

1.08 Operation And Maintenance Data

- A. Submittals shall be as required under provisions of Division 01, and Section 26 0500.
- B. Installation and Start-Up Requirements shall be clearly identified, described and/or detailed. Include bound copies of programming and operating instructions.
- C. Maintenance Data shall include component parts diagrams and Lists, calibration, adjustment, and preventative maintenance procedures, troubleshooting procedures, and repair or replacement procedures.

1.09 Qualifications

- 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.

1.10 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products as required under the provisions of Division 1, and Section 26 0510, Basic Electrical Materials and Methods.
- B. Accept products on site in factory containers. Inspect for damage. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

1.11 Environmental Requirements

- 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.

Part 2 Products

2.01 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.

2.02 Level Switches

- A. Tuning fork level switches shall be as manufactured by Endress+Hauser Liquiphant FTL51 Series, or equal.
- B. Level switches shall be of the frequency shift tuning fork type designed for operation on a 24VDC power source. The switch shall be provided with an adapter sleeve for adjustable mounting.
- C. The level switches shall be approved by FM for use in Class I, Division 1, Group D locations. The sensor and stem material shall be stainless steel and the housing shall be coated aluminum with 3/4" NPT conduit entries.
- D. Level switch stem lengths shall be as required for each mounting and sensing level situation.

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 16195 for nameplate, circuit number marker, and wire marker, etc. requirements.

3.02 Field Quality Control

A. Field inspection and testing will be performed under provisions of Section 16960.

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 0705, Electrical Testing and Equipment.
- B. Calibrate and/or verify each device for the zeros, ranges, spans, and setpoints indicated on the Drawings.

3.04 Demonstration

- A. Demonstrate calibration and operation of devices.
- B. Provide systems demonstration under provisions of Section 26 0710, 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. 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 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 in Section 26 0500, Common Work Results for Electrical.
- 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 calibration kit(s) and all spares at the time of, and as a condition of, acceptance.

End of Section

Section 40 9000 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 22, Division 23, 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 Related Work Specified Elsewhere

- A. Section 22 1000: Plumbing Materials and Methods
- B. Section 26 0500: Electrical General Requirements
- C. Section 26 0510: Basic Materials and Methods
- D. Section 40 0500: Process Equipment General Requirements

- E. Section 40 9100: Instrumentation and Control for Process System
- F. Section 43 2515: Wastewater Non-clog Dry Pit Submersible Pumps

1.03 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 in writing and ENGINEER shall provide written direction to CONTRACTOR 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.

1.04 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, MIOSHA, and local, county, state, and federal laws; and in accordance with the published codes, standards, and specifications of the following organizations:

- 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. MIOSHA Michigan Occupational Safety and Health Administration
- 7. NEC National Electric Code
- 8. NEMA National Electrical Manufacturers Association
- 9. NFPA National Fire Protection Association
- 10. OSHA Occupational Safety and Health Administration (U.S. Depart. of Labor)
- B. Equipment, materials, and systems shall be U.L. labeled or listed except for classes of materials and equipment not available with such listing.

1.05 Guarantee and Warranties

- A. 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.

1.06 Improvements

A. Manufacturer's improvements involving specified systems or equipment needed to fulfill the intent of these specifications, and required to fulfill functionally the operational requirements, shall be provided at no additional cost to OWNER.

1.07 Submittals

- A. Shop Drawings and Product Data:
 - 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 3300, 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" mylar 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. 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.
- 5. 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.
- 6. Dimensional outline drawings of all control and instrument enclosures including designated conduit or wireway entrances, internal equipment layouts and structural details.
- 7. Internal wiring diagrams of control enclosures identifying terminals and showing external and interconnecting terminals and field mounted devices.
- 8. Details necessary for fabrication of equipment specific to these control systems.
- 9. Working and/or construction drawings, showing conduit layout, locations, details, size, wire size and type and cables therein.
- 10. Technical information for all devices furnished.
- 11. Cable schedule detailing each cable, routing and all connections, as described in a format approved by ENGINEER.
- 12. A riser diagram shall be provided showing all cables, wires and conduits.
- 13. 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.
- 14. Complete parts lists of all materials and components incorporated in the system.
- 15. Individual manufacturer's instruction manuals for all devices.
- 16. CONTRACTOR shall submit as-built drawings, instruction manual material and assistance as required by Sections 01 7700, Closeout Procedures.

1.08 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.

1.09 Storage

A. 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.

1.10 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.

1.11 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.

1.12 **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.

1.13 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.

1.14 Tools and Spare Parts

- A. One complete sets of any specialty instrument required to adjust and calibrate the instrumentation equipment shall be furnished with the equipment.
 - 1. They shall include hand tools for maintenance and calibration such as: unique screwdrivers and wrenches plus other tools as required.
 - 2. They shall be supplied in a durable case.
 - 3. Calibration tools for instrumentation equipment such as magmeters, flowmeters, and pneumatic instruments shall also be provided.
- B. A universal, portable input-output calibrator shall be provided.
 - 1. 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.
 - 2. Output section shall contain 6 current and 5 voltage ranges.
 - 3. Internal power supply shall contain 3 ranges.
 - 4. A self contained portable potentiometer shall also be provided.
 - 5. Tester shall be Fluke model 789 or ENGINEER approved equal.

1.15 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.
 - 1. 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.
 - 2. Spare parts shall be 100% of the manufacturer's recommended spare parts for each device.

C. Spare parts for specific equipment, if necessary to be furnished by CONTRACTOR, shall be specified in the Sections for the specific equipment.

1.16 Source Quality Control

- 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 Instrumentation 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 at ENGINEER's office in Taylor, Michigan 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. The 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. The 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. The 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 CONTRACTOR's 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 Instrument Calibration

- A. 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.
- B. 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.
- C. Provide a list and basic specifications for instruments used.
- D. Provide a written report to ENGINEER on each instrument certifying that it has been calibrated to its published specified accuracy.
 - 1. Report shall include applicable data as listed below plus any defects noted, correction action required and correction made.
 - 2. Data shall be recorded on prepared forms and shall include not less than the following items.
 - a. Facility identification (name, location).
 - b. Loop identification (name or function).
 - c. Equipment tag and serial numbers.
 - d. Scale ranges and units.
 - e. Test mode or type of test.
 - f. Input values or settings.
 - g. Expected outputs and tolerances.

- h. Date of actual calibration.
- i. Actual readings.
- j. Explanations or special notes as applicable.
- k. Tester's certification with name and signature.

3.07 System Validation

- A. 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.
 - 1. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.
- B. 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).
 - 1. During system validation, make provisional settings on levels, and alarms.
 - 2. 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.
 - 3. Verify that alarms and logic sequences operate in accordance with the specifications.
- C. Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation.
- D. Immediately correct defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.
- E. Provide a report certifying completion of validation of each instrument system.
 - 1. Report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices.
 - 2. Data sheets shall be similar to those used for calibration.

3.08 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 startup.
 - 3. OWNER reserves the right to set the schedule.

3.09 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.

3.10 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.

3.11 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 9100 Instrumentation and Control

Part 1 General

1.01 Section Includes

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 0500: Electrical General Requirements.
- B. Section 26 0510: Basic Materials and Methods.
- C. Section 40 9000: Process Instrumentation, Controls and Monitoring Equipment General Requirements.

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 Quality Assurance

- A. Contractor's Verification:
 - 1. CONTRACTOR shall provide written verification that equipment, materials and components are designed for the operations specified herein and are free from any defects in workmanship and not previously installed or otherwise used.

1.05 Submittals

- A. See Section 40 9000, Instrumentation and Controls for Process Systems, and Section 26 0500, Electrical General Requirements.
- B. Operation and Maintenance Data:
 - 1. Submit operating and maintenance instructions of all instrumentation and control components and equipment in accordance with Section 40 9000, Process Instrumentation, Controls and Monitoring General Requirements and Section 26 0500, Electrical General Requirements.

1.06 Description of System Operation

- A. General:
 - 1. Percentages reference max 480 RPM of Pumps 1, 2 and 4, and 710 RPM of proposed dry weather Pump 3. The description below describes operation of the three existing (Pump 1, Pump 2 and Pump 4) with the new dry weather (Pump 3) in place of the originally described LEAD pump.

DRY WEATHER pump is running:

On *increasing* flow:

| When DRY WEATHER pump reaches 65% | |
|---|-----------------------|
| Nothing happens yet. | |
| When LEAD pump reaches 100% | Pump at MAX RPM value |
| LAG pump starts | |
| After Lag Pump Running delay | |
| DRY WEATHER pump turned OFF | |
| When LAG nump reaches 65% | Pumn at MID RPM value |
| Nothing hannens vet | |
| When LAG numn reaches 90% | |
| BACKUP numn starts LAG numn reduced to fixe | ad 75% |
| When BACKIIP nump reaches 65% | |
| LAG numn increased to fixed 95% | |
| When BACKUP nump reaches 90% | |
| STANDBY pump starts. BACKUP pump reduced | to fixed 75% |
| When STANDBY pump reaches 65% | |
| BACKUP pump increased to fixed 95% | |
| When STANDBY pump reaches 90% | |
| DRY WEATHER pump increased to fixed 100% | Pump at TOP RPM value |
| LAG pump increased to fixed 100% | r r |
| BACKUP pump increased to fixed 100% | |
| STANDBY pump continues in Automatic | |

From this point, on *decreasing* flow:

| When STANDBY pump reaches 30% BACKUP pump decreased to fixed 75% | Pump at NOT MID RPM value Pump at FAST RPM value |
|---|---|
| When STANDBY pump reaches 5% | Pump at MIN RPM value |
| STANDBY pump turns off | Pump at OFF RPM value |
| When BACKUP pump reaches 30% | |
| LAG pump decreased to fixed 75% | |
| When BACKUP pump reaches 5% | |
| LAG pump returns to Automatic | |
| BACKUP pump turns off | |
| When LAG pump reaches 30% | |
| DRY WEATHER pump decreased to fixed 75% | |
| When LAG pump reaches 5% | |
| DRY WEATHER pump returns to Automatic | |
| LAG pump turns off | |
| DRY WEATHER pump continues in Automatic | |
| When DRY WEATHER pump reaches 5% | |
| Nothing changes, still runs in Automatic | C |
| | |

Part 2 Products

2.01 Equipment

D.

E.

- 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:

| Function: Operation: Float Material: | Provide discrete level measurement. Changes in level causing tilt in float activating switch. Polypropylene, or material compatible with the fluid that is contact with the float |
|--|--|
| Cable: | Length as required; Type SO Nitril PVC jacketed with 3 No. 14 AWG stranded conductors. |
| Switch Rating: | Mechanical switch (no mercury), 10 amps at 115 VAC. |
| Proximity Switches: | |
| Function: | Provide indication of presence or movement of mechanical components |
| Operation: | Changes in level causing tilt in float activating switch. |
| Enclosure: | Stainless steel, side sensing, intrinsically safe |
| Cable: | Length as required; Type SO Nitril PVC jacketed with 3 No. 14 AWG stranded conductors. |
| Switch Rating: | SPDT switch, 10 amps at 115 VAC, 3 amps at 24 VDC. |
| Manufacturer: | Subsea Model 11 GO Switch by Emerson Process Management |
| Intrinsically Safe Relay: | |
| Function: | Interface control in explosive atmospheres |
| Type: | Solid state electronic |
| Input Signal Value: | Less than 1 ma @ 9.6 VDC |
| Output Signal Value: | Contact closure - 10 amp resistive rated 2 N.O. + 2 N.C. |
| | independent and isolated |
| Power Supply: | 120 V - 1 PH - 60 HZ |
| Power Consumption: | 6 watts or 9 V.A. |
| Power Terminals: | Plug-in quick connect tabs |
| Approval: | FM (Factory Mutual) |
| Sensitivity Adjust: | 10,000 ohm to 1 megohm |
| Manufacturer: | Turck IM1-22EX-R, or equal |
| | |

F. Electronic Dual Current Switch:

| Function: | Monitor input signal and trip at set point |
|---------------|---|
| Type: | Direct current switch suitable for panel mounting |
| Input: | 4 to 20 MA |
| Output: | DPDT relay contacts rated 5 A at 117 VAC noninductive |
| Power: | 117 VAC 50/60 HZ 🛛 10% |
| Manufacturer: | Adtech, or equal |

| | Function: Type: Input: Color Cap: Color Designation: Mounting: | Visual indication of control function Heavy-duty; oil-tight or weatherproof as required; transformer type; push-to-test LED 120 volts, 60 HZ Plastic Red - "Stop" or "Alarm" Green - "Start" or "Running" Blue - "Overload" White - "Power On" or "Opened" Amber - "Closed" Clear - "Defined Status" "Ground" Mounting hole 1 13/64" D; Pilot hole 1/4" D; Space between holes 9/16" minimum |
|----|---|--|
| H. | Pushbutton: | |
| | Function: Type: | Manual operator control Oil-tight or weatherproof, momentary or maintained contact as required; emergency stop shall be |
| | Contacts: | 1 N.O. and I.N.C. (minimum) Provide contact arrangements as required to perform desired control |
| | Rating: | 10 amp @ 120 VAC continuous |
| | Mounting: | Mounting hole 1 13/64" D |
| | Operator: | Extended head Start, open, close or run function - black operator Stop function - red operator Silence - black operator |
| I. | Selector Switch: | |
| | Function: | Manual control mode selection |
| | Туре: | Heavy-duty, Oil-tight or weatherproof, as required |
| | Application: | See Contract Drawings |
| | Positions: | Two-three-four (as required) |
| | Contacts: | Form a or Form b (as required) (Form c not acceptable) |
| | Operator: | Knob level type |
| | Contact Rating: | 120 VAC - 10 amp continuous (60 amp make – 6 amp |
| | Mounting | Mounting hole 1 13/16" D |
| | Options: | (1) Spring return as required |
| | 1 | (2) Cylinder key lock as required |
| J. | Gage Pressure Transducer, | /Transmitter: |
| | Function: | Provide analog pressure measurement |
| | Туре: | Pressure transducer with 4-20 mA output proportional |
| | | to system pressure |
| | Housing: | NEMA 4 |
| | Fill Fluid: | Silicone Oil |
| | Wetted Parts: | 316L Stainless Steel |
| | Output: | 4 – 20 mA analog signal |
| | manufacturer: | Siemens Sitrans P |

G. Pilot Indicating Light:

K. Redundant Power Supply:

| | Function: Type: Input: Output: Housing: Ripple: Manufacturer: | Provide 24 volt power Switching redundant power supply with controller 115 VAC 24 VDC NEMA 12 No more than 50 mV peak to peak Puls QS10.241 supply, with YRM2.DIODE or SOLA SDN- 24-100P supply with SDN 2.5-20RED |
|----|---|---|
| L. | Temperature Transducer/Trar | nsmitter: |
| | Function: Type: Housing: Range: Wetted Parts: Output: Manufacturer: | Provide analog temperature measurement Transmitter/transducer with 4-20 mA output proportional to ambient temperature NEMA 7 0 - 100 degrees Fahrenheit 316L Stainless Steel 4 - 20 mA analog signal Certification: Factory Mutual (Class I, Division I) Dwyer Instruments model TTE-106-W-LCD with A-287 pipe mounting bracket, or ENGINEER approved equal. |
| М. | Pressure Switch: | |
| | Function: Type: Range: Contacts: Manufacturer: | Provide discrete indication of pressure Machine Tool, NEMA 4, diaphragm actuated 3-150 psi nominal on decreasing pressure 6-30 psi nominal adjustable differential 475 psig nominal maximum pressure DPDT Square-D or Allen-Bradley |
| N. | Intrinsic Safety Barrier: | |
| | Function: Type: Input Signal Value: Output Signal Value: Approval: Manufacturer: | Interface control in explosive atmospheres Solid state electronic Less than 1 VDC to field device 4-20 mADC to control system FM Turck IM33-11Ex-HI/24VDC or approved equal |
| 0. | Submersible Pressure Transdu | cer/Transmitter: |
| | Function: Type: | Provide analog pressure measurement Pressure transducer with 4-20 mA output proportional to system pressure |
| | Wetted Parts: Output: Accuracy: Manufacturer: | 316 Stainless steel 4 – 20 mA 0.25% KPSI/Esterline |

P. Panel Meters (Indicators):

| 0 | Function: Type: Adjustments: Housing: Input: Power: Manufacturer: Signal Splitter: | Provide visual indication of process variables 4-digit LCD with field selectable decimal point Field adjustable zero and span NEMA 4X 4 to 20 maDC 24 VDC loop powered Precision Digital or approved equal |
|----|---|---|
| ν. | Function: | Provide two output signals with one input signal |
| | Type: Adjustments: Housing: Input: Output: Power: Manufacturer: | Field adjustable zero and span NEMA 1 4 to 20 maDC 4 to 20 maDC 24 VDC Acromag, Adtech, or approved equal |
| R. | Ice Cube Relays (for use within | PLC Panel and Valve Control Panel only): |
| | Function: Type: Contact Arrangement: Construction: Mounting: Options: Manufacturer: | Relay logic Heavy-duty plug in, with internal pilot light 4PDT minimum, 10 amp rating Clear polycarbonate cover with epoxy encapsulated coil Pin terminal-type socket Pilot light, Time delay function (where applicable) IDEC, Square-D, Allen-Bradley, General Electric, Cutler- Hammer, or approved equal |
| S. | Machine Tool Relays (for all use | e except within the PLC Panel and Valve Control Panel) |
| | Function: Type: Contact Arrangement: Mounting: Options: Manufacturer: | Relay logic Heavy-duty Machine Tool 4PDT minimum, 10 amp rating, field convertible contacts Relay mounting track, direct subpanel mount Time delay function (where applicable) IDEC, Square-D, Allen-Bradley, General Electric, Cutler- Hammer, or approved equal |
| Т. | Circuit Breakers: | |

| Function: | Provide overcurrent protection |
|---------------|--|
| Туре: | Molded-case. Provide voltage and amperage ratings as |
| | required |
| Manufacturer: | Square-D, or approved equal |

U. Uninterruptible Power Supply and Manual Bypass Switch:

| Function: | Provide back-up 120 VAC power. |
|-----------|--|
| Туре: | On-line, double-conversion with fault tolerant auto- |
| | bypass |
| Input: | 120 VAC |
| Output: | 120 VAC (minimum of six 5-15/20R receptacles) |

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| VA Output: | As required to meet full load plus 20% spare capacity |
|----------------|--|
| Runtime: | Provide batteries as necessary for 1 hour of run-time at |
| | full load |
| Communication: | DB9 serial port (RS232 and contact closure supported) |
| Bypass Switch: | Manual bypass switch shall be make-before-break type. |
| Manufacturer: | Powerware (Eaton) Ferrups, Tripp-Lite (SmartOnline |
| | "SU" series) or ENGINEER approved equal |
| | |

V. Ethernet Switch:

| Function: | Provide connectivity between Ethernet devices |
|---------------|---|
| Туре: | Unmanaged, 5 RJ45 ports, 10/100 MBit/s |
| Power: | 24 VDC |
| Manufacturer: | Sixnet, Phoenix Contact, Hirschmann, or ENGINEER approved equal |

W. Control Panel Power Surge Suppressor:

| Function: | Provide surge protection |
|---------------|--|
| Туре: | 120 VAC, 1-phase, 3-wire, 10 kA |
| 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):

| Function: | Provide surge protection |
|---------------|--|
| Туре: | 150 VAC, 1250 amp surge current MOV |
| 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):

| Function: | Dissipate electrical surge |
|---------------|---|
| Туре: | Socket-mount |
| Surge Rating: | 10kA (8 x 20 microseconds), SAD hybrid technology |
| Manufacturer: | Phoenix Contact TT-2-PE-M-24VDC or approved equal |

Z. Ultrasonic Level Transmitter:

| Service (s): | Chemical storage tank storage level |
|--------------------------|--|
| Measuring Range: | Oft to 15ft of liquid |
| Accuracy: | ± 0.2% full scale |
| Repeatability: | ± 0.1% full scale per year |
| Response Time: | 150 ms |
| Pressure Range: | N/A |
| Temperature Range: | Operating: 14° to 158°F (-10°C to 70°C) |
| Storage: | -40° to 176°F (-40°C to 80°C) |
| Transmitter Type: | Ultrasonic |
| Output Signal: | 4-20 mA |
| Enclosure Rating: | NEMA 4X (IP68) |
| Process Connections: | Process flange on tank |
| Power Supply: | 120 VAC |
| Materials: | Sensor Housing: Kynar |
| 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. Sierra Monitor Corporation, Sentry Gas Systems.
 - b. MSA Ultima X element/sensor.
- BB. PLC Panel:
 - 1. 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.
 - 2. 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.
 - 3. 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.
 - 4. 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.
 - 5. 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.
 - 6. Inside surfaces shall be painted with a high-gloss white and the outside surface shall be painted with a color selected by the OWNER.
 - 7. 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.
 - 8. Each floor standing-type panel shall be equipped with interior panel service lighting system and quadplex receptacle as a minimum.
 - 9. 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.

- 10. 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.
- 11. 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.
- 12. 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.
- 13. 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.
- 14. The radio shall be mounted in the PLC panel.

Part 3 Execution

3.01 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.

3.02 Field Quality Control

A. Testing on equipment, materials, and components herein specified shall be as specified in Section 40 9000, Process Instrumentation, Controls and Monitoring Equipment – General Requirements, Section 26 0500, Electrical General Requirements and Section 26 0510, Basic Materials and Methods.

3.03 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.

3.04 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:

- B. Instrument Calibrator:
 - 1. 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 transmittes.
 - 2. Indication: LCD readout.
 - 3. 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 | .02% Rdg. +2 LSD |
| mA | 0 to 24 | 0.001 mA | .02% Rdg. +2 LSD |
| mV | -10.00 mV to +75.00mV | .025 % of range +1 LSD | |
| Resistance | 0 Ω to 3200 Ω (measure) 15 Ω to 3200 Ω (source) | 0.01 Ω to 1.0 Ω | |
| Frequency (source) | 2.0 to 1000.0 CPM 1 to 1000 Hz 1.0 to 10.0 kHz | 0.1 CPM 1Hz 0.1 kHz | ±.05% of setting ±.05% of setting ±.25% of setting |
| Frequency (measure) | 1 CPM to 10 kHz | 5 digits | 0.05% Rdg +1 count |
| Loop Supply | 24 V dc | | 10% |

3.05 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
Division 43 Process Gas and Liquid Handling, Purification and Storage Equipment

Section 43 2515 Wastewater Non-clog Dry Pit Submersible Pumps

Part 1 General

1.01 Summary

- A. Section Includes: Labor, materials and equipment necessary for furnishing the fabrication, production, installation, erection and testing of the dry pit submersible wastewater pumps and accessories specified in this Section as shown on Drawings or listed on Schedule. Equipment provided shall be placed in proper operating condition in full conformity with Contract Documents, engineering data, instructions and recommendations of the equipment manufacturer.
- B. Anchor bolts shall be installed under Section 40 0500 in accordance with certified prints furnished by the equipment manufacturer.

1.02 Related Work Specified Elsewhere

- A. Section 01 3300: Submittal Procedures
- B. Section 01 6000: Product Requirements
- C. Section 40 0500: General Equipment Requirements

1.03 Reference Standards

- A. ASTM A48, Gray Iron Castings
- B. ASTM A743, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant Castings for General Application
- C. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
- D. Hydraulic Institute Standards, latest edition.

1.04 System Description

- A. Design Requirements
 - 1. Minimum and maximum system discharge pressures are included herein.
- B. Performance Requirements:
- C. Each pump shall be designed to operate continuously at the intersection of its pump curve and the minimum system pressure at some reduced speed with available net positive suction head as shown without cavitation and without requiring throttling to prevent cavitation or overloading the motor. Multiple pumps running concurrently shall also satisfy the above condition.
- D. The preferred operation region of the pump, as defined by HI 9.6.3, shall fall on the pump curve at the duty point indicated in the schedule.
- E. The entire pump curve between the maximum and minimum system pressures shall be in the allowable operating range of the pump, as defined by the pump manufacturer.

- 1. Pump motor nameplate horsepower shall be sufficient for non-overloading operation at all points on the performance curve of the impeller selected to meet the duty point including horsepower requirements of the drive. At no point shall the required brake horsepower exceed 85% of the motor nameplate horsepower multiplied by the motor service factor.
- F. Field performance tests shall be performed as specified in this Section for verification of design and performance requirements.
- G. Pump shall comply with HI 9.6 with respect to vibration.

1.05 System Responsibility

A. Pump manufacturer may rely upon information on Pump Schedule pertaining to steadystate operating conditions (flow, TDH, NPSHA, etc.). However, pump manufacturer shall be responsible to review this Specification Section as well as maximum and minimum system pressures.

1.06 Submittals

- A. Submit the following items under provisions of Section 01 3300:
 - 1. Shop Drawings.
 - 2. Product Data.
 - 3. Certified Shop Tests.
 - 4. Pump Warranty.
 - 5. Calculations of specific speeds, with backup data..
 - 6. Spare Parts and tools List.
- B. Shop Drawings:
 - 1. Each submittal shall be complete, incorporating information and data listed herein and additional information required to evaluate the proposed pump's compliance with Contract Documents.
 - 2. Each pump, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Pump Schedule.
 - 3. Data to be submitted shall include the following:
 - Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
 - b. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
 - c. Weight of component parts and an assembly weight.
 - d. Listing of lubricants required for the pumps with a minimum of four equivalent and compatible natural and/or synthetic lubricants produced by different manufacturers. The listing shall include the estimated quantity of lubricant required for one year of operation.

- e. Sample data sheet of pump and motor nameplates including information contained thereon.
- f. Orientation and clearance requirements for each pump.
- 4. Submit written reports and certifications to ENGINEER documenting testing and/or inspection results.
- 5. Submit operation and maintenance data and parts lists for inclusion in the O & M manuals.

1.07 Quality Assurance

- A. General:
 - 1. The equipment covered by these specifications is intended to be standard equipment of proven performance from manufacturers with more than 25 years experience providing similar equipment.
- B. Inspection:
 - 1. Work done in accordance with this specification shall be subject to inspection. OWNER or ENGINEER shall have access to 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. Products or parts which does not conform to the requirements of this specification shall be made satisfactory or shall be rejected and replaced.

1.08 Delivery, Handling, Storage and Protection

- A. Special care shall be exercised during delivery, distribution and storage of pumps and motors to avoid damage and setting up stresses. Damaged equipment shall be rejected and replaced at CONTRACTOR's expense.
- B. Pumps shall be complete when shipped and the manufacturer shall use all due and customary care in preparing them for shipment to avoid damage in handling or in transit. Particular care shall be taken to see that the parts are completely closed and locked in position before shipment. Pumps shall be securely bolted or otherwise fastened to skids in such a manner that they may be safely handled.
- C. Preparation for transport: Prepare pumps for shipping as follows:
 - 1. Ensure pumps are dry and internally protected against rusting and galvanic corrosion.
 - 2. Protect pump ends against mechanical damage to flange faces.
 - 3. Set pumps in best position for handling.
- D. Storage: Use the following precautions during storage:
 - 1. Protect pumps against weather. Where practical store pumps indoors. Maintain pump temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support pumps off the ground or pavement and protect in watertight enclosure.

E. Handling: Pumps whose sizes require handling by crane or lift shall be slung or rigged to avoid damage to exposed pump parts. Suction and discharge nozzles, in particular, shall not be used as lifting or rigging points.

1.09 Identification

- A. Each unit of equipment shall be identified with the equipment item number.
- B. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified for complete identification.
- C. Equipment tag numbers will be assigned by ENGINEER.

1.10 Spare Parts

- A. CONTRACTOR shall obtain from the equipment manufacturer and submit to ENGINEER the following spare parts lists in accordance with the procedures and requirements set forth in the General Conditions and Division 01.
- B. A list of parts and supplies that are either normally furnished at no extra cost with purchase of the pump or specified herein to be furnished as part of the Contract.
- C. A list of additional items recommended by the manufacturer to assure efficient operation for a period of ten years at the particular installation.
- D. Spare parts shall be the recommended parts for start-up and five (5) years of operation.
- E. Parts shall be completely identified with a numerical system to facilitate part inventory control and stocking. Each part shall be properly identified by a separate number. Those parts that are identified for more than one size, shall have the same parts number.
- F. Spare parts shall be delivered to ENGINEER or as ENGINEER directs.
- G. Tools and Lubricants:
 - 1. Furnish a complete set of any special tools required for the maintenance and operations of this equipment.
 - 2. Furnish a one-year, supply of each type of lubricant required for this equipment.

Part 2 Products

2.01 Manufacturers

- A. Subject to compliance with requirements, manufacturers offering products which may be included in the Work include the following:
 - 1. Vertical Pumps:
 - a. Flygt/Xylem
 - b. ENGINEER-approved equal

2.02 Manufactured Units

A. Pumps:

- 1. Wastewater pumps shall be dry pit submersible units, as approved by ENGINEER.
- 2. Pumps shall be used to pump untreated domestic wastewater and shall be of the nonclog type capable of passing solid spheres up to 3 inches in diameter. Direction of rotation and arrangement of suction and discharge piping shall be as indicated on the drawings.
- 3. Manufacturer shall have installations of like or similar application with a minimum of 25 years service for this pump size.

2.03 Components

- A. Volute/Casings:
 - 1. Casing shall be cast with extra thick walls made of close-grained cast iron conforming to ASTM A48, Class 35B. It shall be one-piece, constant velocity equalizing pressure with smooth fluid passages large enough to pass any solid that can pass through the impeller. The volute shall be side flanged centerline or tangential discharge. Diffusion vanes are not permitted. All nuts and bolts shall be type 316 stainless steel.
 - 2. The volute shall be furnished with cleanout openings located at the impeller centerline, to allow access to the impeller.
 - 3. The casing shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge piping. Casings shall be tested with internal hydrostatic pressure of 1.5 times the design head or 1.25 times the shutoff head, whichever is greater and under this test pressure they shall show no leakage or distortion.
 - 4. The casings shall be provided with suitable openings for air vents, drainage, gauges and with suitable eyebolts for lifting.
 - 5. One-half-inch IPS taps fitted with solid brass plugs shall be provided at the suction and discharge flanges for installation of pressure gauges.
 - 6. Pump shall have flat face flanged suction and discharge connections in conformity with the current ANSI B16.1, Class 125, machined so as to make a watertight joint. Flanges shall be drilled, and the boltholes shall be located to straddle centerlines.
 - 7. A stainless steel nameplate shall be attached to each pump casing. The nameplate shall include design data pertaining to the respective pump on which it is mounted.
- B. Wear Rings:
 - 1. Wear rings shall be provided on the suction so that clearances can be maintained throughout the life of the rings and minimize recirculations.
 - 2. Wear rings shall be stainless steel, with the impeller wear ring approximately 50 Brinell softer than the front head wear ring.
 - 3. Wear ring clearance adjustment shall be attained through impeller adjustment shims or screws.

- C. Base and Suction Elbow:
 - 1. Pump shall be designed to be supported by a reinforced concrete base with sole plates provided by pump manufacturer.
 - 2. A heavy duty cast one-piece turbulence reducing elbow made of close-grained cast iron conforming to ASTM A48 CL30 shall be provided that meets the ANSI HI 9.8 requirement for approach velocity less than 8 feet per second. The elbow shall create flow performance equal to a long radius reducing elbow but with a height profile equal to or less than a short radius elbow and be furnished with 1/2-inch gauge connections and handhole cleanout located 180 degrees from the suction flange. The suction flange will be 30-inches, B16.1 Cl 125 lb. flat-faced flange.
 - a. In lieu of this, furnish a long radius elbow, reducing from 30 inches to pump suction dimensions.
- D. Impeller:
 - 1. Impeller shall be hard ASTM A-532 (Alloy III A) 25% chrome cast iron, semi open, multi-vane, nonclog design. Leading edges of impeller shall be hardened to Rc 60.
 - 2. Impeller shall be dynamically balanced and secured to the shaft by means of a key and/or impeller bolt.
 - 3. Impeller waterways and clearance between the pump's full diameter impeller periphery and volute cutwater shall be capable of passing a 3-inch solid sphere.
 - 4. Impellers shall be trimmed to specifically meet the conditions of operation.
 - 5. Impeller to volute clearance shall be adjustable.
- E. Motor:
 - 1. Pumps shall be driven by completely sealed, electric submersible squirrel cage induction motors. Motors shall comply with NEMA MG1, Part 31, Definite Purpose Inverter-Fed Motors when used with variable frequency drives.
 - 2. Pump motors shall have cooling characteristics suitable to permit continuous operation, in a totally unsubmerged condition.
 - 3. Motor cooling shall be affected by a heat exchanger plate between the motor enclosure and volute. Pump designs requiring pumpage to be circulated in the motor jacket or requiring an external source of cooling fluid shall not be accepted.
 - 4. Motor jacket shall be sealed to the motor housing with O-rings. Stator-winding and lead shall be insulated with moisture-resistant Class F insulation for continuous duty in 40 degrees Celsius ambient. Motor shall be designed for continuous duty capable of ten (10) starts per hour. Automatic reset normally closed thermal overloads shall be imbedded in the motor windings to provide overheating protection.
 - 5. Motor/pump shaft shall be one-piece, 416 or 431 stainless steel. Rotor shall be dynamically balanced to meet standard HI vibration limits.
 - 6. Cable leads shall enter the top of the motor and shall allow the cable-to-motor connection to be accomplished in the field without soldering. Power and control

lead wires are to be double sealed as it enters the motor in such a manner that cable-wicking will not occur.

- 7. A cable strain relief shall be an integral part of the sealing system.
- 8. Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be 0-ring sealed.
- 9. Pumps shall be provided with two separate tandem-mounted mechanical seals to prevent the pumped liquid from entering the rotor/stator cavity area to ensure reliability of operation. The upper and lower seals shall be mounted to rotate in the same direction.
- 10. Upper seal shall be completely immersed in an oil bath and seal the oil chamber and the motor housing. Lower seal mating surfaces shall be immersed in the oil bath sealing the pump volute and the oil chamber. The upper running in an oil reservoir consisting of one stationary ceramic, silicon carbide, or tungstencarbide ring and one rotating carbon ring, and the other consisting of one stationary and one rotating silicon carbide or tungsten-carbide ring, with each pair held in contact by a separate spring so that the outside pressure assists spring compression in preventing the seal faces from opening. The seals shall require neither maintenance nor adjustment and shall be easily replaceable.
- 11. Two moisture detection devices shall be installed so that they will detect moisture in either the seal or stator cavity measuring resistivity between the probes. They shall be wired internally to the control cable connection at the top of the motor.
- 12. O-ring sealed inspection plugs shall be provided in the mechanical seal oil chamber for ease in inspection, draining and filling of oil.
- 13. The pump shall rotate on a grease lubricated thrust bearing and oil lubricated radial bearing. Lower shaft bearings shall be locked in place to prevent shaft movement and to take thrust loads.
- F. Anchor Bolts:
 - 1. Anchor bolts shall be sleeved (for new concrete base), 316 stainless steel and furnished under this Section of the Work.
 - 2. Bolts shall be long enough to permit 1-1/2-inches of grout beneath the baseplate and provide adequate anchorage into structural concrete.
- G. Thermo/Moisture Controls and Monitoring:
 - 1. Equipment shall be provided to monitor moisture entering the oil cavity, motor winding over temperature, and motor thrust bearing over temperature.
 - 2. High winding temperature sensing shall be provided for each phase.
 - 3. Temperature, moisture, status and other data shall be transmitted to a central unti by two control wires. The central unit shall be a Flygt MAS 801 or approved equal.
 - 4. The local area network shall be capable of connectintg to the central unit with a RJ45 jack.

5. The central unit shall be capable of shutting down the pumping unit through interconnections as indicated on electrical drawings.

2.04 Source Quality Control

- A. Testing, General:
 - 1. Testing shall be performed as specified herein and in accordance with Section 40 0500, General Equipment Requirements.
- B. Shop Tests:
 - 1. Prior to shipment, each pump shall be fully tested on water at the manufacturer's plant. The purpose of the shop tests shall be to demonstrate that the pump to be furnished will meet the requirements of the Specifications.
 - 2. Tests shall consist of running the pump with furnished impeller at their rated capacity, head, and speed. Performance data including efficiency and horsepower shall be collected and noted as part of the performance curve.
 - 3. Pumps shall be tested in accordance with the standards of the Hydraulic Institute. Certified copies of the test results and the performance curves, for each of the pumps to be furnished, shall be submitted to ENGINEER and approved prior to shipment of the pumps to the jobsite.

2.05 Shop Painting

- A. Pumping units shall receive a shop application of the coating as herein specified.
 - 1. Shop painting shall be compatible with paint to be applied in the field under Section 09 9000, Painting and Coating.
- B. Ferrous metal surfaces, except machined, cadmium plated, galvanized, stainless steel or plastic covered surfaces shall be painted. All surfaces to be painted, shall be shop blast cleaned to a near-white finish per SSPC Specification SP-10, thoroughly cleaned of all dirt, grease, scale, oil, rust and other foreign matter, washed with benzene before painting or coating and shall be thoroughly dry prior to painting.
- C. Ferrous surfaces, except stainless steel, shall be coated with two coats of an epoxy polyamide.
- D. Dry film thickness of the coating shall be 6-8 mil thickness, with the maximum as recommended by the manufacturer.
- E. Machined and finished surfaces shall be protected with a suitable approved lubricant to prevent rusting.
- F. Coatings shall be applied in strict conformity with the manufacturer's application directions.

Part 3 Execution

3.01 Examination

A. Examine the areas and conditions under which equipment is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 Preparation

- A. Make field measurement as necessary to verify or supplement manufacturer's dimensions.
- B. Sequence, coordinate and integrate installations of equipment for efficient flow of the Work.

3.03 Installation

- A. Equipment provided under this Section shall be assembled, installed, and placed in proper operating condition in full conformity with specifications, engineering data, instructions, and recommendations of the equipment manufacturer.
- B. Set anchor bolts with template provided by equipment manufacturer.
- C. Provide ample room and facilities for inspection, repair and adjustment.
- D. Alignment shall be checked in accordance with the Standards of the Hydraulic Institute after installation and there shall be no strain transmitted to the pump.
- E. After completion of installation, including mechanical coupling, factory inspection and performance testing, pump and motor shall be doweled to their rigid base in a manner approved by the manufacturer.

3.04 Field Quality Control

- A. Manufacturer's Field Services:
 - 1. The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment specified under this Section, under provisions of Section 40 0500, General Equipment Requirements.
 - 2. A written report of the installation check shall be submitted to ENGINEER. The report shall be under provisions of Section 40 0500, General Equipment Requirements.
 - 3. In addition to the requirements of the Installation Check and Performance Tests, the manufacturer of the equipment furnished under this Section of the Work shall also furnish start-up services for a one-day period, eight-hour working day, at the site, to assist the OWNER's personnel in initial equipment start-up and to instruct OWNER's personnel in the proper maintenance and operation of the equipment. Training shall be in accordance with Section 40 0500, General Equipment Requirements.
- B. Performance Tests:
 - 1. After the pumping unit has been erected, performance tests shall be conducted. The purpose of these performance tests shall be to demonstrate that the unit has been properly erected, and that it will operate satisfactorily and meet the specified conditions and the warranty of CONTRACTOR.
 - 2. For the purpose of these tests, OWNER will furnish the electricity. Sewage will be pumped when available.
 - 3. Performance tests shall be conducted under the supervision of ENGINEER with the cooperation of the manufacturer's factory representative.
 - 4. It is intended that these tests shall be carried out by operating the pumping unit through the range specified, a minimum duration of 1 hour and repeated as necessary until it is shown to the satisfac

- 5. Throughout these tests of the pumping equipment the motor and pump must run smoothly without vibration or heating, otherwise the test shall be stopped and not again undertaken until the unit shall have been put into condition to comply with the requirements for smoothness of operation.
- 6. Make observations of head, capacity and drive motor input to determine general performance and fitness for service specified.
- 7. During field testing, record pump vibration at the specified rating points to ensure meeting the requirements of the specifications and as a reference for future operation.
- C. Correct or replace promptly, defects or defective equipment revealed by or noted during tests at no expense to OWNER, and if necessary, repeat tests until results acceptable to ENGINEER. Furnish all labor, piping, equipment and materials necessary for conducting tests.
- D. Make all adjustments necessary to place equipment in satisfactory working order at time of above tests.
- E. In event that CONTRACTOR is unable to demonstrate that unit will satisfactorily perform the service required and that it will operate free from vibration and heating, the pumping unit may be rejected. CONTRACTOR shall then remove and replace the equipment at his own expense.

3.05 Pump Schedule

| A. | No. of l | Jnits: | One |
|----|----------------|---|---------------------------------------|
| B. | Type: | | Dry Pit Submersible |
| C. | Locatio | on: | Third Avenue PS Dry Well |
| D. | Service | 2: | Raw Sewage |
| E. | Installa | ation (Horizontal or Vertical): | Vertical |
| F. | Duty P | oint | |
| | 1. 2. 3. | Capacity (gpm): Total Head (feet): Minimum discharge pressure | 18 mgd 65 feet 45 feet |
| G. | NPSHa | : | 30 feet |
| | 1. | NPSHr at Duty Point: | 15 feet below NPSHa |
| H. | Head a | nd Speeds | |
| | 1. 2. | Minimum Shutoff Head: Maximum Pump Speed: | 100 feet 750 rpm |
| I. | Motor: | | 4160-3-60, Submersible, Inverter Duty |

Exhibits

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



CERTIFICATE OF SUBSTANTIAL COMPLETION

350-02

(Rev. 04/2019)

| WT Project No.: | Project Name: | | |
|--|---------------------|--------------|----|
| Owner / Municipality: | | | |
| Owner Project No.: | Department: | | |
| Project Location: | | | |
| Contractor: | Subo | contractor: | |
| Contract Date.: Project or Designated Por | tion Shall include: | e of Issuanc | e: |
| | | | |

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

required by the Contract Documents except as stated below.

DEFINITION OF DATE OF SUBSTANTIAL COMPLETION

The date of Substantial Completion of the Work or designated portion thereof, is the date certified by ENGINEER when construction is sufficiently complete, in accordance with the Contract Documents, so 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, which has been prepared by ENGINEER, is attached hereto. The failure to include any items on such list does not alter the responsibility of 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 OWNER and CONTRACTOR for security, maintenance, heat, utilities, damage to the Work and insurance shall be as follows:

(Note - OWNER's and CONTRACTOR's legal and insurance counsel should determine and review insurance requirements and coverage; CONTRACTOR shall secure consent of surety company, if any.)

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.

WADE TRIM

CHANGE ORDER NO.____

305.08 (Rev. 04/2019)

| Prepared By: Date of Issuance: | | | | |
|--|-------------------------------|---|--|--|
| WT Project No.: | Project N | ame: | | |
| Owner / Municipality: | | | | |
| Owner Project No.: | Depart | nent: | | |
| Project Location: | | | | |
| Contractor: | | Subcontractor: | | |
| The Contract Document | s are modified as follows upo | on execution of this Change Order: | | |
| Attachments: (List doci | ments supporting change): | | | |
| | | | | |
| CHANGE IN (| CONTRACT PRICE | CHANGE IN CONTRACT TIME | | |
| Original Contract Price: | | Original Contract Times: | | |
| \$ | | Substantial Completion (date): Ready for final payment (date): | | |
| from previo Orders No. to No. \$ | usly approved Change : | from previously approved Change Orders No. to No. : Substantial Completion (days): Ready for final payment (days): | | |
| Contract Price prior to the | s Change Order: | Contract Times prior to this Change Order: | | |
| \$ | | Substantial Completion (date): Ready for final payment (date): | | |
| of this Char \$ | nge Order: | of this Change Order: Substantial Completion (days): Ready for final payment (days): | | |
| Contract Price incorporat | ing this Change Order: | Contract Times with all approved Change Orders: | | |
| \$ | | Substantial Completion (date): Ready for final payment (date): | | |
| RECOMMENDED: | ACCEPTED: | ACCEPTED: | | |
| Ву: | Ву: | By: | | |
| Engineer (Authorized Sig | gnature) Owner (Auth | orized Signature) Contractor (Authorized Signature) | | |
| Date: | Date: | Date: | | |

Change Order becomes effective upon date of final signature.





305.01 (Rev. 04/2019)

| Prepared By: | Date of Issuance: | |
|---|--|--|
| WT Project No.: | Project Name: | |
| Owner / Municipality: | · · · | |
| Owner Project No.: | Department: | |
| Project Location: | · · · · | |
| Contractor: | Subcont | ractor: |
| This Change Proposal is submi If this Change Proposal is accepte | tted in accordance with Paragra ed, either in whole or in part, a Cha | aph 10.06 of the General Conditions. ange Order will be issued to modify the Contract |

Detailed Description of Proposed Change:

Attachments: (List documents attached supporting requested change):

CHANGE IN CONTRACT PRICE

of this requested Proposal:

CHANGE IN CONTRACT TIME

of this requested Change Proposal:

Substantial Completion (days): Ready for final payment (days):

Engineer's Decision on Change Proposal:

\$

| ENGINEER: | OWNER: | CONTRACTOR: |
|--|-------------------------------------|--|
| By: Engineer (Authorized Signature) | By: Owner (Authorized Signature) | By: Contractor (Authorized Signature) |
| Date: | Date: | Date: |



CONSTRUCTION CHANGE REQUISITION WORK CHANGE DIRECTIVE

| | | No. <u>305.05</u> (Rev. 05/2019) |
|-----------------------|----------------|--|
| Prepared By: | | Date: of |
| WT Project No.: | Project Name: | |
| Owner / Municipality: | | |
| Owner Project No.: | Department: | |
| Project Location: | | |
| Contractor: | Subcontractor: | |

Description or Work:

Reason:

| ltem | | | Quantity Increase | | Amount Increase |
|---------|----------------------------------|------|----------------------|----------------|--------------------|
| No. | Description | Unit | (Decrease) | Unit Price | (Decrease) |
| | | | | | |
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| | | | | | |
| | | | | Net Cost | |
| Request | for Contract Time Extension: Add | D | ays N | lot Applicable | |

Request for Contract Time Extension:

____ Days

Not Applicable

Contractor (Representative)

Wade Trim (Representative)

Date

| WADE TRIM | CONSTRUCTION CHANG WORK CHA | E REQUISITION NGE DIRECTIVE No |
|--|--|--------------------------------------|
| | D | ate: |
| | Pa | age: of |
| Work Order Auth If authorized, the Cont as payment in full the | orization: Approved Approved as Noted Not Approved tractor agrees to do the work outlined above under the direction of the Engineer, basis of payment as indicated. | ed , and to accept |
| Contract Time: | Add Time Extension of Days Not Applicable | ; |
| Accepted By: | | |
| | Contractor (Representative) | Date |
| Recommended By | y: Wade Trim (Representative) | Date |
| Approved By: | | |
| | Owner (Representative) | Date |





| WT Project No.: | | Project Name: | | | | |
|------------------|---------|--|------------------------|---|-------------------|--------------------------------------|
| Owner / Municip | pality: | | | | | |
| Owner Project N | No.: | | | Departmen | nt: | |
| Project Location | n: | | | | | |
| Contractor: | | | | | Subcontractor: | |
| Date: | | | | | | |
| Prepared by: | | | | | | |
| Subject / Descri | iption: | | | | | |
| Classification: | - | Clarification or Minor Change i Minor Change i | n Work W n Addition | Interpretation /hich Does N h to Work | on of Contract Do | cuments ct Price or Contract Time |

Reason:

Sheet 1 of



NON-COMPLIANCE NOTICE / ORDER TO REMOVE DEFECTIVE WORK NO.

| | | | | 330.06 (Rev. 01/2018) |
|--|--|---|--|---|
| Job No.: | | | D | ate: |
| Project: | | | Ti | ime: |
| | | | | |
| Attention: | | | | |
| You are hereby notified that: | | | | |
| | | | | |
| | | | | |
| | | | | |
| does not conform to the Contract F Drawing No Unde | Requirements. The Specification the provisions of the Contra | ion violated in Section | ı, Art are | icle, |
| | | | | |
| | | | to the Owner | |
| Non-complying work may | be required to be removed an | id replaced at no cost | to the Owner. | until the defective work has been |
| removed. | se removed and replaced at r | | | |
| It shall be the Contractor's responsibility of the Owner a address the deficiency. If you refut with sufficient documentation that | sibility to determine the correct and his authorized representat e the initial findings, it is your your position can be evaluate | ctive action plan nece tive for their review ar responsibility to make ed. All actions descrif | ssary to bring the work nd concurrence that sa e your position known to bed above shall be do | into compliance. This action plan id corrective action will adequately the Owner and his representative ne in writing as near to the date of |
| the Notice as possible, but no later | then ten (10) days after the is | ssuance of said Notic | е. | |
| | | | Resident Project Re | presentative (Signature) |
| | Non-Compliance | Notice Received By | Contractor | |
| | | _ | | |
| Received On: Date | — | Ву: | (Sig | nature) |
| | | Title: | | |
| Corrective action to be taken by Co | ontractor: | | | |
| | | | | |
| | | Dv <i>r</i> | | |
| Date | _ | Бу. <u></u> | (Sig | nature) |
| | Owner' | 's Acknowlegen | nent | |
| Accepted | Accepted as Noted | U | nacceptable | Pricing |
| | | | | |
| | | | | |

(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: |

| Item | em Description of Item | | Date | Actions to be Taken to Close | Verified by | |
|------|------------------------|--------|------|------------------------------|-------------|------|
| No. | | minais | Bate | | Initials | Date |
| | | | | | | |
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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. Items(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 contractrual 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:

| Deve | lop Preliminary Punch List | Date: |
|---------------------------------------|---|---|
| Resp Engir | onsibility: Owner, Contractor and Enginee eer shall have 2 weeks to prepare the pu | er nch list. |
| Complete Preliminary Punch List Items | | Date: |
| Resp Contr | onsibility: Contractor actor shall have 2 weeks to complete the | items on the punch list. |
| Deve | lop Final Punch List (if needed) | Date: |
| Resp If nee | onsibility: Owner, Contractor and Enginee ded, a second and final punch list will be | r prepared within 2 weeks by Engineer. |
| Com | olete Final Punch List Items | Date: |
| Resp Contr | onsibility: Contractor actor shall have 2 weeks to complete the | items on the second and final punch list. |
| Proc | ess Final Payment | Date: |
| Engir Owne | eer will have 2 weeks to review and sub or for final payment upon satisfactory com | mit final pay request documents from Contractor to the pletion of punch list items by Contractor. |
| This notic | e signed and dated through mutual agre | ement of CONTRACTOR and ENGINEER will initiate the time |
| sequence | for the approved execution of finalizing _ | |
| Contract | n | , Michigan, dated |
| COPY: | OWNER | Date: |
| | | ENGINEER's Representative |
| | | Date: |
| | | |
| | | |

CONTRACTOR's Representative

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: | | Sub | contractor: | |
| | | | | |
| 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 Price Impact: Contract Schedule Impact: | | | |

Information Requested

Attachments



Response

Page: _____ of _____

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)

| ` | - | - | |
|---|----|---|--|
| 4 | ~f | | |

| | | Page: <u>1</u> 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 | | |
| 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



| | Drain of Norman | | | | |
|--|-----------------|--------------|-----|----|--|
| WI Project No.: | Project Name: | | | | |
| Owner / Municipality: | | | | | |
| Owner Project No.: | Department: | | | | |
| Project Location: | | | | | |
| Contractor: | Sub | contractor: | | | |
| | | | | | |
| 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:

 Company:

 Address:

 Telephone:

Signature: _____

| ACTION STATUS | | | |
|--|------------------------------------|--|--|
| ENGINEER'S REVIEW | RESPONSE REQUIRED OF CONTRACTOR | | |
| Approved (A) Approved as Noted (AN) Revise and Resubmit (RR) Not Approved - See Remarks (NA) | None Confirm Resubmit | | |
| 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. | | | |
| By: Da | te: | | |



WARRANTY DATA SHEET

350.07

(Rev. 04/2019)

| | | | Date Page | : :of |
|----------------------------------|----------------------|--------------------|--------------|----------|
| WT Project No : | Projec | t Name: | 0 | |
| Owner / Municipality: | | | | |
| Owner Project No.: | Depart | tment: | | |
| Project Location: | | | | |
| Contractor: | | Subcontractor: | | |
| Contractor Address: | | Phone: | | |
| Project Description: | | | | |
| Supplier/Vendor: Address: | | Phone: | | |
| Manufacturer: | | Serial No. | | |
| Manufacturer Part No.: | | Asset / Part Name: | | |
| Location: | | Owner ID No.: | | |
| Warranty Provider: | | | | |
| Warranty Type (labor, parts, par | rts and labor, etc.) | | | |
| Warranty Description: | | | | |
| Warranty Class/Limitations: | Limited Other: | 1 year | 2 year | |
| Warranty Date: | | Initial Re | ading: | |
| Warranty Expiration Date: | | Maximum Re | ading: | |
| Exclusions: | | | | |
| Comments: | | | | |

City of Flint Flint, Michigan 3rd Ave Pump Station

Low Flow Pump

MAK-2112

MAK: Michael Lancina <u>MAKcontrolsLLC@gmail.com</u> (734) 770-8785 City of Flint: John Florshinger <u>iflorshinger@cityofflint.com</u> (810) 577-8909



ELECTRICAL ENGINEERING | CONTROLS DESIGN PANEL FABRICATION | PROJECT MANAGEMENT

MAK-2112 3rdAve Pump System Features & Functions



Scope

Provide SCADA system engineering support to the 3rd Ave Dry Weather Pump Project.

Justification

At 3rd Ave, one of the existing high-flow pumps will be replaced with a low-flow pump and a new valve actuator. The existing VFD will be reused.

A new level switch to monitor flow to the river will be installed. A new High Flow / Low Flow control scheme will be implemented.

At the WWTP, two new valve actuators and a Vault Flood switch will be added and a new control scheme implemented.

Description

MAK Controls will modify the Filter PLC configuration to accommodate the new I/O and control scheme. There is ample existing I/O available in the Filter panel for the proposed new controls.

MAK Controls will add sufficient I/O to the Ferrous building controls to accommodate the new Vault Flooding control scheme (specific I/O modules subject to change).

The new controls will require modification to several existing FactoryView screens. New graphics will be created to monitor the new Level switch and control the new valve actuators.

System commissioning support and engineering support during construction will be provided as necessary.

Project Documentation: existing panel and loop drawings will be updated.

Payment Terms

MAK Controls requests the following payment terms:

| The fo | llowing is a | a lump-sum | proposal for | this project: |
|--------|--------------|------------|--------------|---------------|
| \$10,9 | 06.00 | | | |

MAK-2112 3rdAve Pump Bill of Materials



| Qty | Item | Manufacturer | Description |
|-----|------------------------------|--------------|-------------------------|
| 3 | Point I/O, Base | Rockwell | Terminal Base w/ RTB |
| 2 | Point I/O, Discrete Input | Rockwell | DC Input, 4-channel |
| 1 | Point I/O, Relay Output | Rockwell | Relay Output, 2-channel |
| | Rockwell Hardware / Software | | |
| 1 | CCS Services Calc | MAK Controls | engineering services |
| | Engineering Services | | |

MAK-2112 3rdAve Pump 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 or 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

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 except as set forth herein. Purchaser agrees to indemnify and save purchaser harmless except as set forth herein. Purchaser 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:

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

WATER RESOURCES DIVISION

PERMIT FOR CONSTRUCTION OF WASTEWATER SYSTEMS

| SITE NAME: | Flint WWTP | PERMIT NUMBER: | P41003245 v. 1 |
|-----------------------------------|-----------------------|---------------------|--|
| PERMITEE CONTACT NAME: | Jeanette Best | PERMIT ISSUED DATE: | June 17, 2021 |
| PERMITEE CONTACT PHONE NUMBER: | 810-766-7210 | ISSUED TO: | City of Flint Water Pollution Control Facility |
| PERMITEE CONTACT EMAIL: | jbest@cityofflint.com | PROJECT NAME: | Third Avenue Pumping Station Improvements |
| SITE COUNTY: | Genesee | PROJECT LOCATION: | University Ave at the Flint River, City of Flint |

APPLICATION SUBMISSION NUMBER: HP9-130D-VMECW

<u>REQUIRED NOTIFICATIONS</u>: The permittee shall provide <u>Startup Notification</u> (just prior to excavation) and <u>Completion Notification</u> (upon completion of the project) per the permit schedules in MiWaters.

ISSUED UNDER THE AUTHORITY OF THE DIRECTOR OF THE DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY (EGLE)

| Issued By: | |
|---------------------|--|
| CAplemeth | |
| Charles Bennett, PE | |

| Reviewed By: | | | |
|-------------------------------|--|--|--|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Charles Bennett | | | |
| Sr Environmental Engineer | | | |
| EGLE-Water Resources Division | | | |
| 517-290-4095 | | | |

cc: GCHD

GCDC-WWS Tiffany Harrison, PE, Wade Trim EGLE-FD-WIFS

GENERAL PERMIT CONDITIONS

- a. This **PERMIT** only authorizes the construction, alteration, addition, or improvement of the wastewater system as described herein and is issued solely under the authority of Part 41 of Act 451.
- b. Issuance of this **PERMIT** does not authorize any violation of federal, state, or local laws or regulations, nor does it obviate the need to obtain other permits or approvals from EGLE or other units of government as may be required by law.
- c. This **PERMIT** expires two (2) years after the above date of issuance unless construction starts prior to the expiration date in accordance with R 299.2939(2) of the Part 41 Administrative Rules.
- d. Any portion of the herein described facilities <u>constructed prior to the date of issuance</u> is not authorized by this **PERMIT** and is a violation of Act 451.
- e. No sewer shall be placed into service unless and until the outlet sewer has been constructed, tested, and placed into service.
- f. Failure to meet any condition of this **PERMIT** or any requirement of Act 451 constitutes a violation of Act 451.
- g. The applicant must provide notice of impending construction to public utilities and comply with the requirements of the Underground Facility Damage Prevention and Safety Act, PA 174 of 2013, as amended (MISS DIG).
- h. All earth changing activities must be conducted in accordance with Part 91, Soil Erosion and Sedimentation Control, of Act 451.
- i. All construction activity, including groundwater dewatering, impacting wetlands shall be conducted in accordance with Part 303, Wetlands Protection, of Act 451.
- j. If water withdrawal, via dewatering activities, is associated with this project, authorization under Part 327 is required for new or increased large quantity withdrawals over 100,000 gallons per day. A Part 327 permit is required for new or increased large quantity withdrawals over 2,000,000 gallons per day.

SPECIAL PERMIT CONDITIONS

1. This permit does not have any additional special permit conditions above and beyond the General Permit Conditions listed above.

FACILITIES DESCRIPTION

Third Avenue Pumping Station (TAPS) to undergo the removal and replacement of a 60-inch diameter isolation valve with a new 60-inch diameter knife gate and coupling, including an electric motor actuator; removal of an existing wet weather pump with an 18-mgd dry-pit submersible pump for dry weather (12,500 gpm at 65 feet TDH), including piping, fittings, valves, variable frequency drive, instrumentation and controls, and all necessary appurtenances and piping as shown on the plans and described in the specifications for the proper operation of the facility. Work will also include replacing two existing valves at the Water Pollution Control Facility (WPCF) with two new valves, a 72-inch and a 50-inch knife gate, including a new valve vault structure and appurtenances, and all necessary appurtenances and piping as shown on the plans and described in the specifications for the proper operation of the facility. Work at both the TAPS and the WPCF will require temporary line stops; bypass pumping up to 50 MGD will be required at the TAPS. Replacement of one existing pump with the 18-mgd dry weather pump will derate the TAPS firm pumping capacity from 108 MGD to 90 MGD.