

Copy No.

**CITY OF FLINT, MICHIGAN
WATER POLLUTION CONTROL
AERATION SYSTEM IMPROVEMENTS**

Contract Number 200-156238-19001

SRF No. 5696-01

Bidding Documents

Specifications

Prepared by



Lansing, Michigan

May 2020

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ADVERTISEMENT FOR BIDS

CITY OF FLINT WPC
AERATION SYSTEM IMPROVEMENTS

SRF No. 5693-01

Contract 200-156238-19001

Sealed Bids will be received by the City of Flint, Michigan at the office of the City of Flint Finance Department – Division of Purchases and Supplies, 1101 S Saginaw St, Room 203, Flint MI 48502 up to 3:00 p.m., prevailing local time, on June 29, 2020, and then publicly opened and read aloud for the construction of Contract 200-156238-19001. One fully completed digital copy and hard copy of the Bid, including all necessary support forms shall be submitted at time of bid. The digital copy of bid shall be submitted to City of Flint Finance Department – Division of Purchases and Supplies at purchasingbids@cityofflint.com.

The Work consists of improvements to the aeration system at the City of Flint Water Pollution Control Facility. The works includes installation of three new aeration blowers. Also includes installation of a low energy mixing system in secondary treatment influent and effluent channels, portions of the Battery B Aeration tanks and primary tank influent channels. The works also includes installation of fine bubble diffuser equipment in one tank of the Battery B aeration system, replacement of valves, piping and instrumentation within the Aeration Tank Galleries, replacement and removal of a number of existing channel gates, concrete repairs to the existing structures, and electrical and instrumentation improvements.

Bids shall be on a lump sum basis for the Work.

The Drawings and Project Manual under which the Work is to be done are on file and may be examined at the office of the City of Flint Water Pollution Control Facility; at Construction Association of Michigan in Bloomfield Hills, Michigan; at McGraw-Hill Construction Dodge; at Builders Exchange of Grand Rapids, Lansing, and Saginaw, Michigan; at Construction News Service in Detroit, Michigan; and at the office of the ENGINEER, Tetra Tech, Inc., 401 S. Washington Square Suite 100, Lansing, Michigan 48933.

Bidding Documents may be obtained on or after May 29, 2020, through the City of Flint, Finance Department Division of Purchases and Supplies. Plans will be available to view, purchase or download from on the City's Purchasing page of the City of Flint's web site at <https://www.cityofflint.com/finance/purchasing/bids-2/> under "open bids" and the specific bid or proposal number assigned.

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

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

A mandatory Pre-Bid Conference will be held at 9:00 a.m. on June 9, 2020, at City of Flint Water Pollution Control Facility, 4652 Beecher Road, Flint MI 48532. Attendance at meeting at the site is not allowed; bidder shall attend through virtual meeting. Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are required to attend and participate in the conference via Windows Teams meeting attendance. Interested parties wishing to attend the Pre-Bid meeting shall request meeting attendance information no later than 4:00 p.m on June 8, 2020 from brent.bode@tetrattech.com. The necessary login information shall then be provided.

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Interested bidder may schedule a tour of the Site per details provided at Pre-Bid meeting. Prospective Bidders who fail to attend and register at the meeting will be disqualified from bidding for the Work. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

CONTRACTOR will not engage in unlawful discrimination on the basis of race, color, religion, national origin, age, sex, height, weight, marital status, or unrelated disability. Bids from minority- and female-owned organizations are encouraged.

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

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

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

Joyce McClane
City of Flint Division of Purchases and Supplies

SECTION 00110 - CONTRACTOR'S QUALIFICATION STATEMENT

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

1. Project Information:

OWNER: City of Flint, MI Water Pollution Control

Address: _____

Project: Aeration System Improvements

Contract No. 200-156238-19001

2. Bidder Information:

Name of Organization: _____

Address: _____

Telephone: _____

Facsimile: _____

3. Surety company:

Name of Surety: _____

Agent's Name: _____

Surety Rating: A.M. Best's Rating

Address: _____

Telephone: _____

Facsimile: _____

4. Type of Organization, check if:

☐ Corporation ☐ Partnership ☐ Joint Venture ☐ Sole Proprietorship

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If Corporation:

Date and State of Incorporation _____

List of Executive Officers

Name

Title

If Partnership:

Date and State of Organization: _____

Names of Current General Partners

Type of Partnership

☐ General

☐ Publicly Traded

☐ Limited

☐ Other (describe): _____

If Joint Venture:

Date and State of Organization: _____

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

If Sole Proprietorship:

Date and State of Organization: _____

Name and Address of Owner or Owners

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

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

If yes, show names and addresses of affiliated companies.

6. Current Projects: In Schedule B, provide the following (If joint venture, list each participant's projects separately):

- A. List major engineered construction projects under current contract by this organization.
- B. Are there any projects that are beyond final completion date?
- C. Are there any projects that have liquidated damages presently being assessed?
- D. Are there any judgments, claims, arbitration proceedings or suits pending or outstanding against your organization or its officers?
- E. Has your organization filed any lawsuits or requested arbitration on any of these projects?

7. Financial Resources:

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

Name of Bank: _____

Address: _____

Account Manager: _____

Telephone: _____

Facsimile: _____

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

\$500,000 to \$2,000,000

\$2,000,000 to \$5,000,000

\$5,000,000 to \$10,000,000

\$10,000,000 or more

8. Experience Record: In Schedule D, provide:

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

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

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

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

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

1. Total cases.

2. Lost workday cases.

3. Non-fatal cases per number of lost workdays.

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

Subscribed and sworn to
before me on _____

County, Michigan

By: _____
Title: _____

Dated: _____

Signature _____

Printed: _____

Notary Public

COMPLETED PROJECTS

SCHEDULE A

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

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

CURRENT PROJECTS

SCHEDULE B

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

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

FINANCIAL RESOURCES

SCHEDULE C

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

EXPERIENCE RECORD

SCHEDULE D

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

General Types of Work Performed by Own Work Force: _____

SECTION 00200 - INSTRUCTION TO BIDDERS

ARTICLE 1 - DEFINED TERMS

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

ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

- 2.01 Complete sets of the Bidding Documents for the purchase sum, if any, stated in the Advertisement or Invitation to Bid may be obtained from the Issuing Office.
- A. Upon written request, copies of the Bidding Drawings, in their entirety or by individual Drawing, may be obtained in electronic format from the Issuing Office for the purchase sum of \$30 per Drawing. Upon receipt of payment, Drawings will be made available in the latest version of AutoCAD and transmitted to Bidder on a CD or DVD. E-mail transfer of Bidding Drawings will not be permitted.
- 2.02 Complete sets of Bidding Documents must be used in preparing Bids; neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 2.03 OWNER and ENGINEER in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

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

- a. Subcontractors, when required to be identified in the Bid, may be required to complete the Contractor's Qualification Statement for Engineered Construction, including Schedules A, B, C, and D. Subcontractor's may be required to demonstrate a project experience record as required in this Paragraph.

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

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

- A. To examine and carefully study the Bidding Documents, including any Addenda and other related data identified in the Bidding Documents (including "technical data" referred to in Paragraphs 4.02 through 4.05, inclusive);
- B. To visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;
- C. To become familiar with and satisfy Bidder as to all Federal, State, and local Laws and Regulations that may affect cost, progress, and performance of the Work;
- D. To promptly notify ENGINEER of all conflicts, errors, ambiguities, or discrepancies which Bidder has discovered in or between the Contract Documents and such other related documents;
- E. To carefully study all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions, and carefully study all reports and drawings of a Hazardous Environmental Condition, if any, at the Site which have been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions;
- F. To obtain and carefully study (or assume responsibility for doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto;
- G. To agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;
- H. To correlate the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents;
- I. To determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work;

4.02 Subsurface and Physical Conditions

- A. The Supplementary Conditions identify:
 - 1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that ENGINEER has used in preparing the Bidding Documents.
 - 2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that ENGINEER has used in preparing the Bidding Documents.
- B. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated conditions appear in Paragraphs 4.02, 4.03, and 4.04 of the General Conditions.

4.03 Underground Facilities

- A. Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to OWNER and ENGINEER by owners of such Underground Facilities, including OWNER, or others.

4.04 Hazardous Environmental Condition(s)

- A. The Supplementary Conditions identify:
 - 1. Those reports and drawings relating to Hazardous Environmental Condition(s) identified at the Site, if any, that ENGINEER has used in preparing the Bidding Documents are identified in Paragraph 4.06.
- B. Copies of reports and drawings referenced in Paragraph 4.04.A, that are not included with Bidding Documents, may be examined City of Flint Water Pollution Control Facility, 4652 Beecher Road, Flint MI 48532 during regular business hours. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.06 of the General Conditions has been identified and established in Paragraph 4.06 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated on such drawings.
- C. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated on Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work appear in Paragraph 4.06 of the General Conditions.

- 4.05 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 4, that without exception the Bid is premised upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given ENGINEER written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents and the written

resolutions thereof by ENGINEER are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

ARTICLE 5 - PRE-BID CONFERENCE

A mandatory Pre-Bid Conference will be held at 9:00 a.m. on June 9, 2020, at City of Flint Water Pollution Control Facility, 4652 Beecher Road, Flint MI 48532. Attendance of meeting at the site is not allowed; bidder shall attend through virtual meeting. Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are required to attend and participate in the conference via Windows Teams meeting attendance. Interested parties wishing to attend the Pre-Bid meeting shall request meeting attendance information no later than 4:00 p.m. on June 8, 2020, from ENGINEER at brent.bode@tetrattech.com. The necessary login information shall then be provided. Interested bidder may schedule a tour of the Site per details provide at Pre-Bid meeting. Prospective Bidders who fail to attend and register at the meeting will be disqualified from bidding for the Work. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 6 - SITE AND OTHER AREAS

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

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

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

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

ARTICLE 8 - BID SECURITY

8.01 A Bid must be accompanied by Bid Security made payable to OWNER in an amount of five percent of Bidder's maximum Bid price and in the form of a certified check, bank check, or a Bid Bond on the form attached in Section 00430, issued by a surety meeting the requirements of Paragraphs 5.01 and 5.02 of the General Conditions.

8.02 The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required Contract Security and met the other conditions of the Notice of Award, whereupon the Bid Security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required Contract Security within ten (10) days after the Notice of Award, OWNER may annul the Notice of Award and the Bid Security of that Bidder will be forfeited. The

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Bid Security of other Bidders whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of seven (7) days after the Effective Date of the Agreement or 91 days after the Bid opening, whereupon Bid Security furnished by such Bidders will be returned.

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

ARTICLE 9 - CONTRACT TIMES

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

ARTICLE 10 - LIQUIDATED DAMAGES

- 10.01 Provisions for liquidated damages, if any, are set forth in the Agreement.

ARTICLE 11 - SUBSTITUTE AND "OR-EQUAL" ITEMS

- 11.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or "or-equal" items. Whenever it is specified or described in the Bidding Documents that a substitute or "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by CONTRACTOR and consideration by ENGINEER is set forth in the General Conditions and may be supplemented in the General Requirements.

ARTICLE 12 - SUBCONTRACTORS, SUPPLIERS, AND OTHERS

- 12.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to OWNER in advance of a specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within five (5) days after Bid opening, submit to OWNER a list of all such Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity if requested by OWNER. If OWNER or ENGINEER, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, OWNER may, before the Notice of Award is given, request apparent Successful Bidder to submit a substitute, in which case apparent Successful Bidder shall submit an acceptable substitute. Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and OWNER may consider such price adjustment in evaluating Bids and making the contract award.
- 12.02 If apparent Successful Bidder declines to make any such substitution, OWNER may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid Security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which OWNER or ENGINEER makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to OWNER and ENGINEER subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.06 of the General Conditions.

- 12.03 CONTRACTOR shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom CONTRACTOR has reasonable objection.
- 12.04 The manufacturers of certain equipment items are required to submit Equipment Data Sheets to ENGINEER prior to the time Bids are received. Equipment items requiring such submittals are identified in the Specifications. Failure on the part of the manufacturer to provide this information in the form and at the time prescribed in the individual Specification Sections where the equipment is described will make their equipment subject to rejection by OWNER.

ARTICLE 13 - PREPARATION OF BID

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

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

200-156238-19001

00200-6

052920

ARTICLE 14 - BASIS OF BID; EVALUATION OF BIDS

14.01 Lump Sum

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

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

ARTICLE 15 - SUBMITTAL OF BID

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

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

15.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the Advertisement or Invitation to Bid and shall be enclosed in an opaque sealed envelope plainly marked with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid Security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid shall be addressed to OWNER's office. A digital copy of the Bid shall also be submitted at the same time to the City of Flint Finance Department – Division of Purchases and Supplies at purchasingbids@cityofflint.com.

ARTICLE 16 - MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be modified or withdrawn by an appropriate document duly executed in the manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

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

ARTICLE 17 - OPENING OF BIDS

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

ARTICLE 18 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 19 - AWARD OF CONTRACT

- 19.01 OWNER reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. OWNER further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be non-responsible. OWNER may also reject the Bid of any Bidder if OWNER believes that it would not be in the best interest of the Project to make an award to that Bidder. OWNER also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate Contract terms with the Successful Bidder.
- 19.02 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.
- 19.03 In evaluating Bids, OWNER will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested on Bid Form or prior to the Notice of Award.
- 19.04 In evaluating Bidders, OWNER will consider the qualifications of Bidders, in accordance with Article 3 of this Section, and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the Supplementary Conditions.
- 19.05 OWNER may conduct such investigations as OWNER deems necessary to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities to perform the Work in accordance with the Contract Documents.
- 19.06 If the Contract is to be awarded, OWNER will award the Contract to the Bidder whose Bid is in the best interests of the Project.

ARTICLE 20 - CONTRACT SECURITY AND INSURANCE

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

ARTICLE 21 - SIGNING OF AGREEMENT

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

ARTICLE 22 - SALES AND USE TAXES

22.01 Bidder shall pay all State Sales, Use, and other Taxes that are lawfully assessed against OWNER or Bidder on materials and equipment to be incorporated in Work. Said taxes shall be included in the Contract Price. Refer to General Conditions GC 6.10.

ARTICLE 23 - RETAINAGE

23.01 Provisions concerning CONTRACTOR's retainage are set forth in Article 6 of the Agreement.

END OF SECTION

SECTION 00400 - BID FORM

City of Flint
Water Pollution Control
Aeration System Improvements
SRF No. 5696-01

Contract 200-156238-19001

THIS BID IS SUBMITTED TO:

City of Flint – Finance Department Division of Purchase and Supplies
Owner
1101 S. Saginaw St., Room 203, 2nd Floor
Address
Flint, MI 48502
City, State, Zip

- 1.01 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.
- 2.01 Bidder accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. The Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of OWNER.
- 3.01 In submitting this Bid, Bidder represents, as set forth in the Agreement, that:

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

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

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

- D. Bidder has carefully studied all:
1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions, and
 2. Reports and drawings of a Hazardous Environmental Condition, if any, which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.
- E. Bidder has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder, and safety precautions and programs incident thereto.
- F. Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.
- G. Bidder has correlated the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.
- H. Bidder has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by ENGINEER is acceptable to Bidder.
- I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.
- J. In preparation of this Bid, Bidder acknowledges that it will not discriminate against any employee or applicant for employment with respect to hire, tenure, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of race, color, religion, national origin, age, sex, height, weight, marital status, or a disability that can be reasonable accommodated. OWNER will require this covenant be placed in the Contract with any subcontractor employed in the performance of this Contract.
- K. OWNER will utilize funds from the State Revolving Loan Fund (SRF) on the Project. Bidders acknowledge that they must:
1. Revolving Loan Fund projects require the use of Prevailing Wages as explained in Section 00450.
 2. Revolving Loan Fund projects require the use of the Buy American Contract requirements as explained in Section 00458.

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

L. OWNER will require the use of prevailing wage rates on this Project. Bidders acknowledge that

M. All claims and disputes arising from related Work at Site by other contractors shall be settled in accordance with Paragraph 7.03 of the Supplementary Conditions.

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

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

A. BASE BID PRICE _____ (\$ _____)
(use words) (figures)

B. All specific allowances are included in the price(s) set forth above and have been computed in accordance with Paragraph 11.02 of the General Conditions.

1. Included in the Bid Price is a Lump Sum Allowance for WPC system integration programming in the amount of \$ 150,000.
2. Included in the Bid Price is a Lump Sum Allowance for Unforeseen Conditions in the amount of \$125,000.

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

1. Alternate 1:

Alternate No. 1 generally consists of deletion of all work associated with Battery B Aeration Tank No. 1

(add) (deduct) _____ (\$ _____)
(circle one) words figures

2. Alternate No. 2 generally consists of deletion of compressed air mixing system in Battery B Aeration Tanks No. 1 thru 5.

(add) (deduct) _____ (\$ _____)
(circle one) words figures

- D. Unit Price Adjustments to the Lump Sum Bid Price for this Contract are set forth in the Specifications. The cost for installing quantities listed below shall be included in the Lump Sum Bid Price. If increases or decreases in these quantities occur, the Contract Price will be adjusted by Change Order on the basis of the following:

Item and Location in Specifications	Number of Units to be Included with Bid	Unit for Adjustment	Adjustment Price Per Unit
Pipe Gasket Replacement			
8"-10" Diameter	10	Ea	
12"-18" Diameter	20	Ea	
20"-36" Diameter	10	Ea	
Wall Penetration Repair			
20" Diameter	10	Ea	
Pipe Wall Repair			
12"-18" Diameter	10	Sft	
20"-36" Diameter	10	Sft	
Concrete Repair			
Concrete Repair, Type A	20,000	Ft	
Concrete Repair, Type B	60	Cft	
Concrete Repair, Type C	100	Cft	

1. Adjustment prices are subject to acceptance by OWNER, and rejections of one or more adjustment prices will not invalidate acceptance of this Bid.
2. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities provided, determined as provided in the Contract Documents.

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

Section	Equipment Item	Manufactured By	Price
11371	Blower		\$
11376	Compressed Gas Mixing		\$

7.01 CONTRACTOR shall list subcontractors proposed for the following Work.

<u>Discipline</u>	<u>Subcontractor Name</u>
Demolition	_____
Concrete	_____
Concrete Repair	_____
Painting	_____
Process Piping and Equipment	_____
HVAC	_____
Electrical	_____
Instrumentation	_____

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

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

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

- A. Evidence of Bidder's qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the Contract; and
- B. Required Bid Security in the form of a certified check, bank check, or a Bid Bond; and
- C. Section 00450 – Certificate Regarding Debarment, suspension, and other Responsibility Matters
- D. Section 00450 – Complete Good Faith Effort Worksheet.

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

SUBMITTED on _____, 20____.

State Contractor License No. _____ (If applicable)

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____ (SEAL)

(Individual's signature)

Doing business as: _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____

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

Name (typed or printed): _____

Business address: _____

Phone No.: _____ FAX No.: _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

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

By: _____

(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(CORPORATE SEAL)

Attest _____

(Signature of Corporate Secretary)

Business address: _____

Phone No.: _____ FAX No.: _____

Date of Qualification to do business is _____

A Joint Venture

Joint Venturer Name: _____ (SEAL)

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

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

Joint Venturer Name: _____ (SEAL)

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

Name (typed or printed): _____

Title: _____

Business address: _____

Phone No.: _____ FAX No.: _____

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

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

END OF SECTION

BID BOND**BIDDER** (Name and Address):

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

OWNER (Name and Address):

BID

BID DUE DATE: _____

PROJECT (Brief Description Including Location):

BOND

BOND NUMBER: _____

DATE (Not later than Bid due date): _____

PENAL SUM: _____

(Words)

(Figures)

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

BIDDER

SURETY

_____(Seal)

_____(Seal)

Bidder's Name and Corporate Seal

Surety's Name and Corporate Seal

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

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

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

REQUIRED STANDARD CONTRACT LANGUAGE: CLEAN WATER STATE REVOLVING FUND AND DRINKING WATER REVOLVING FUND

- **Davis-Bacon/Prevailing Federal Wages, Including Labor Standards Provisions**
- **Disadvantaged Business Enterprise (DBE) Requirements***
- **Debarment/Suspension Certification***

*** Bidders should note these sections contain instructions regarding forms/information that must be completed/included with any submitted bid.**

Davis-Bacon/Prevailing Federal Wage Rates

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.

"General Decision Number: MI20200083 05/08/2020

Superseded General Decision Number: MI20190083

State: Michigan

Construction Type: Building

County: Genesee County in Michigan.

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

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.80 for calendar year 2020 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 \$10.80 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 2020. 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	01/03/2020
1	01/24/2020
2	05/08/2020

ASBE0047-002 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 31.82	17.88

BOIL0169-001 03/01/2018

	Rates	Fringes
BOILERMAKER.....	\$ 38.65	26.22

BRMI0009-014 08/01/2019

	Rates	Fringes
BRICKLAYER.....	\$ 33.23	21.28
TILE FINISHER.....	\$ 29.93	18.02

TILE SETTER.....\$ 29.93 18.02

FOOTNOTE:

Paid Holiday: Fourth of July, if the worker was employed by the contractor in any period of seven working days before said holiday within the current calendar year.

CARP0706-001 06/01/2019

	Rates	Fringes
CARPENTER, Includes		
Acoustical Ceiling		
Installation, Drywall		
Hanging, Form Work, and Metal		
Stud Installation.....	\$ 27.21	21.54

ELEC0948-001 11/25/2019

	Rates	Fringes
ELECTRICIAN		
Excludes Low Voltage Wiring.	\$ 38.31	23.06
Low Voltage Wiring.....	\$ 29.46	17.12

ENGI0324-011 06/01/2019

	Rates	Fringes
OPERATOR: Power Equipment		
GROUP 1.....	\$ 39.58	24.35
GROUP 2.....	\$ 36.28	24.35
GROUP 3.....	\$ 33.63	24.35
GROUP 4.....	\$ 31.92	24.35
GROUP 5.....	\$ 31.92	24.35
GROUP 6.....	\$ 26.06	24.35
GROUP 7.....	\$ 23.58	24.35

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/Trackhoe; Bulldozer; Concrete Pump; Crane; Grader/Blade; Highlift; Hoist; Loader; Roller; Scraper; Stiff Leg Derrick; 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)

GROUP 7: Oiler

IRON0025-019 06/01/2019

	Rates	Fringes
IRONWORKER		
REINFORCING.....	\$ 30.98	27.99
STRUCTURAL.....	\$ 36.77	29.03

LABO0334-005 06/01/2019

	Rates	Fringes
LABORER: Landscape & Irrigation		
GROUP 1.....	\$ 20.75	7.10
GROUP 2.....	\$ 18.75	7.10

CLASSIFICATIONS

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

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

LABO1075-002 06/01/2019

	Rates	Fringes
LABORER		
Common or General; Grade Checker; Mason Tender - Brick/Cement/Concrete, Pipelayer; Sandblaster.....	\$ 23.00	13.66

PAIN1052-001 06/01/2018

	Rates	Fringes
PAINTER		
Brush & Roler.....	\$ 24.40	12.95
Spray.....	\$ 25.75	12.95

PAIN1052-004 06/01/2018

	Rates	Fringes
DRYWALL FINISHER/TAPER		
Drywall sanding.....	\$ 26.07	13.50
Hand work.....	\$ 26.07	13.50
Machine work.....	\$ 26.07	13.50

PLAS0016-005 04/01/2014

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 25.58	12.88

PLUM0370-002 06/01/2018

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation; Excludes HVAC System Installation).....	\$ 37.81	20.60
PLUMBER, Excludes HVAC Pipe Installation.....	\$ 37.81	20.60

ROOF0149-005 06/01/2019

	Rates	Fringes
ROOFER.....	\$ 28.53	17.53

* SFMI0669-001 04/01/2020

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	\$ 35.72	23.60

SHEE0007-008 05/01/2018

	Rates	Fringes
SHEET METAL WORKER, Includes HVAC Duct and Unit Installation.....	\$ 30.64	22.76

SUMI2011-008 02/01/2011

	Rates	Fringes
IRONWORKER, ORNAMENTAL.....	\$ 18.48	7.93
TRUCK DRIVER: Tractor Haul Truck.....	\$ 13.57	1.18

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

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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-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

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

WAGE DETERMINATION APPEALS PROCESS

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

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

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour 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.

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END OF GENERAL DECISION"

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

§ 5.5 Contract provisions and related matters.

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

(1) *Minimum wages.* (i) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in Sec. 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

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

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

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) *Withholding.* The (write in name of Federal Agency or the loan or grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of

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

(3) *Payrolls and basic records.* (i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency). The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/whd/forms/wh347.pdf> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency), the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, sponsor, or owner).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under Sec. 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under Sec. 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the (write the name of the agency) or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) *Apprentices and trainees--(i) Apprentices.* Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its

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

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

(iii) *Equal employment opportunity.* The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) *Compliance with Copeland Act requirements.* The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) *Contract termination: debarment.* A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) *Compliance with Davis-Bacon and Related Act requirements.* All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) *Disputes concerning labor standards.* Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

(10) *Certification of eligibility.* (i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(b) *Contract Work Hours and Safety Standards Act.* The Agency Head shall cause or require the contracting officer to insert the following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Sec. 5.5(a) or 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) *Overtime requirements.* No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

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

(3) *Withholding for unpaid wages and liquidated damages.* The (write in the name of the Federal agency or the loan or grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in Sec. 5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

Disadvantaged Business Enterprises (DBE)

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 time-frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date. The DBEs should be given a minimum of 5 days to respond to the posting.
3. Consider in the contracting process whether firms competing for large contracts can be subcontracted with DBEs. Divide total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
4. Encourage contracting with a consortium of DBEs when a contract is too large for one DBE firm to handle individually.
5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.

Subsequent to compliance with the Good Faith Efforts, the following conditions also apply under the DBE requirements. Completed Good Faith Efforts Worksheets (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.
3. If a DBE contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the Good Faith Efforts if soliciting a replacement contractor.
4. The prime contractor must employ the Good Faith Efforts.

Debarment Certification

The prime contractor must provide a completed **Certification Regarding Debarment, Suspension, and Other Responsibility Matters Form** with its bid or proposal package to the owner (Attachment 2).

Attachment 1

**Disadvantaged Business Enterprise (DBE) Utilization
GOOD FAITH EFFORTS WORKSHEET**

**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 www.sam.gov registries may be two resources used to find a minimum of three DBEs.

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

Company Name	Type of Contact	Date of Contact	Price Quote Received	Accepted/ Rejected	Please Explain if Rejected
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	

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

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

Other Efforts (attach extra sheets if necessary):

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

Rev.3-2015

Rick Snyder, Governor



Dan Wyant, Director

**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 e-mail, letter, or fax for each area of work to be subcontracted out. Copies of the solicitation letters/e-mails and fax confirmation sheets must be provided with the worksheet.
3. If less than three (3) DBEs exist statewide for the area of work, then provide documentation that other DBE resources were consulted. This may include the MDOT and www.sam.gov registries and an advertisement in a publication. A printout of the website searched (conducted prior to the end of the bid period) must be submitted.
4. Posting solicitations for quotes/proposals from DBEs on the MITA website (www.mitadbe.com) is highly recommended to facilitate participation in the competitive process whenever possible. The solicitation needs to identify the project and the areas of work to be subcontracted out. A copy of the MITA DBE advertisement must be submitted with the Good Faith Efforts worksheet, if used, or a printout of the resulting quotes posted to the MITA website can be submitted with this form as supporting documentation.
5. If the area of work is so specialized that no DBEs exist, then an explanation is required to support that conclusion, including the documentation required in 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

Attachment 2

***Certification Regarding
Debarment, Suspension, and Other Responsibility Matters***

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

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

Name and Title of Authorized Representative

Name of Participant Agency or Firm

Signature of Authorized Representative

Date

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

Attachment 3

***Frequently Asked Questions About
Disadvantaged Business Enterprise (DBE) Solicitation***

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 MDOT (or by tribal, state and local governments, as long as their standards for certification meet or exceed the standards in EPA policy) can be counted toward the fair share goal. Proof of certification by one of these recognized and approved agencies should be sought from each DBE.

Q: How does a DBE get certified?

A: Applications for certification under MDOT can be found at <http://mdotiboss.state.mi.us/UCP/LearnHowServlet>.

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

Q: If a bidder follows the MDOT 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 MDOT, 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 <http://mdotjboss.state.mi.us/UCP/>. Additionally, the federal System for Award Management (SAM) is another place to search and can be found at www.sam.gov. SAM contains information from the former Central Contractor Registration (CCR) database.

Q: If the bidder does not intend to subcontract any work, what forms, if any, must be provided with the bid proposal?

A: The bidder should complete the Good Faith Efforts Worksheet with a notation that no subcontracting will be done. However, if the bidder is awarded the contract and then decides to subcontract work at any point, then the Good Faith Efforts must be made to solicit DBEs.

Q: 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.

Q: If the prime contractor is a DBE, does he have to solicit DBE subcontractors?

A: Yes, the DBE requirements still apply if the prime intends to subcontract work out. Good Faith Efforts must be used to solicit DBEs.

Q: If the area of work is one where there are less than three DBE contractors, how is the contractor to document this?

A: Copies of printouts from MDOT and SAM showing no DBEs and advertisements soliciting quotes for all subcontract areas, including the questionable areas, will be adequate if the dates on the printouts are prior to the bid or proposal closing date.

SECTION 00458 – AMERICAN IRON AND STEEL CONTRACT LANGUAGE

The Contractor acknowledges to and for the benefit of the city of Flint (“Purchaser”) and the Michigan Department of Environment, Great Lakes, and Energy (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 the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the AIS Requirements, (b) all iron and steel used in the project will be and/or have been produced in the United States in a manner that complies with the AIS Requirements, unless a waiver of the requirements is approved or the State made the determination in writing that the AIS Requirements do not apply to the project, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the AIS requirements, as may be requested by the Purchaser. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

END OF SECTION

SECTION 00500 - AGREEMENT

THIS AGREEMENT is by and between City of Flint, MI

(hereinafter called OWNER) and _____

(hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 - WORK

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

- A. The Work consists of improvements to the aeration system at the City of Flint Water Pollution Control Facility. The works includes installation of three new aeration blowers. Also includes installation of a low energy mixing system in secondary treatment influent and effluent channels, portions of the Battery B Aeration tanks and primary tank influent channels. The works also includes installation of fine bubble diffuser equipment in one tank of the Battery B aeration system, replacement of valves, piping and instrumentation within the Aeration Tank Galleries, replacement and removal of a number of existing channel gates, concrete repairs to the existing structures, and electrical and instrumentation improvements.

ARTICLE 2 - THE PROJECT

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

City of Flint
Water Pollution Control
Aeration System Improvements
SRF No. 5696-01
Contract 200-156238-19001

ARTICLE 3 - ENGINEER

3.01 The Project has been designed by Tetra Tech, Inc., 401 South Washington Square Suite 100, Lansing, MI 48933, who is hereinafter called ENGINEER and who is to act as OWNER's representative, assume all duties and responsibilities, and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 - CONTRACT TIMES

4.01 Time of the Essence

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00500-1

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

4.02 Days to Achieve Substantial Completion and Final Payment

- A. The Work will be substantially completed within 600 days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 630 days after the date when the Contract Times commence to run.

4.03 Liquidated Damages

- A. CONTRACTOR and OWNER recognize that time is of the essence of this Agreement and that OWNER will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty), CONTRACTOR shall pay OWNER one thousand dollars (\$1,000) for each day that expires after the time specified in Paragraph 4.02 for Substantial Completion until the Work is substantially complete. After Substantial Completion, if CONTRACTOR shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER one thousand dollars (\$1,000) for each day that expires after the time specified in Paragraph 4.02 for completion and readiness for final payment until the Work is completed and ready for final payment.

ARTICLE 5 - CONTRACT PRICE

- 5.01 OWNER will pay CONTRACTOR for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to this Paragraph 5.01 in the amount listed below:

- A. For all Work, a Lump Sum of:

_____ (\$ _____)
(use words) (figure)

- B. All specific allowances are included in the price(s) set forth above and have been computed in accordance with Paragraph 11.02 of the General Conditions.

1. Included in the Bid Price is a Lump Sum Allowance for WPC system integration programming in the amount of \$ 150,000.
2. Included in the Bid Price is a Lump Sum Allowance for Unforeseen Conditions in the amount of \$125,000.

- C. All specific OWNER selected alternates listed below are included in the price(s) set forth above and have been computed in accordance with Paragraph 11.01 of the General Conditions.

1. Alternate No. 1 (deduct) \$ _____

2. Alternate No. 2 (deduct) \$ _____

- D. Lump Sum Price Adjustments have been established for this Contract. If increases or decreases in these quantities occur, the Contract Price is to be adjusted by Change Order on the basis of the following:

Item and Location in Specifications	Number of Units to be Included with Bid	Unit for Adjustment	Adjustment Price Per Unit
Pipe Gasket Replacement			
6"-10" Diameter	10	Ea	
12"-18" Diameter	20	Ea	
20"-36" Diameter	10	Ea	
Wall Penetration Repair			
20" Diameter	10	Ea	
Pipe Wall Repair			
12"-18" Diameter	10	Sft	
20"-36" Diameter	10	Sft	
Concrete Repair			
Concrete Repair, Type A	20,000	Ft	
Concrete Repair, Type B	60	Cft	
Concrete Repair, Type C	100	Cft	

1. Adjustment prices are subject to acceptance by OWNER, and rejections of one or more adjustment prices will not invalidate acceptance of this Bid.
 2. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities provided, determined as provided in the Contract Documents.
- E. All specific allowances are included in the above price and have been computed in accordance with Paragraph 11.02 of the General Conditions.
- F. All specific OWNER-selected alternates are included in the price(s) set forth above, and have been computed in accordance with Paragraph 11.01 of the General Conditions.

ARTICLE 6 - PAYMENT PROCEDURES

6.01 Submittal and Processing of Payments

- A. CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

6.02 Retainage

- A. OWNER will make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment in accordance with Paragraph 14.02.C of the General Conditions during performance of the Work as provided in Paragraph 6.02.A.1 below. All such

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

200-156238-19001

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payments will be measured by the schedule of values established in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. The provisions set forth in Michigan Public Acts of 1980, Act No. 524, shall be adhered to by OWNER and CONTRACTOR for retainage. A copy of the Act is included in Section 00615, Act No. 524, Michigan P.A. 1980.
2. The OWNER shall pay up to 70 percent on equipment and material that has been delivered to the site but is not yet installed. Items shall be properly stored per manufacturers guidelines.
3. The OWNER shall pay up to 90 percent on equipment and material that has been installed but is not yet operational.

6.03 Final Payment

- A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER as provided in said Paragraph 14.07.

ARTICLE 7 - INTEREST

- 7.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the prevailing passbook savings rate at the place of the Project.

ARTICLE 8 - CONTRACTOR'S REPRESENTATIONS

- 8.01 In order to induce OWNER to enter into this Agreement CONTRACTOR makes the following representations:
 - A. CONTRACTOR has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.
 - B. CONTRACTOR has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
 - C. CONTRACTOR is familiar with and is satisfied as to all Federal, State, and local Laws and Regulations that may affect cost, progress, and performance of the Work.
 - D. CONTRACTOR has carefully studied all:
 1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions, and
 2. Reports and drawings of a Hazardous Environmental Condition, if any, at the Site which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.
 - E. CONTRACTOR has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data

concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by CONTRACTOR, including applying the specific means, methods, techniques, sequences, and procedures of construction, if any, expressly required by the Contract Documents to be employed by CONTRACTOR, and safety precautions and programs incident thereto

- F. CONTRACTOR does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.
- G. All claims and disputes arising from related Work at Site by other contractors shall be settled in accordance with Paragraph 7.03 of the Supplementary Conditions.
- H. CONTRACTOR has correlated the information known to CONTRACTOR, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
- I. CONTRACTOR has given ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that CONTRACTOR has discovered in the Contract Documents, and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR.
- J. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
- K. CONTRACTOR acknowledges that it shall not discriminate against any employee or applicant for employment with respect to hire, tenure, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of race, color, religion, national origin, age, sex, height, weight, marital status, or a disability that can be reasonably accommodated. OWNER will require this covenant be placed in the Contract with any subcontractor employed in the performance of this Contract. A breach of this covenant shall be regarded as a material breach of the Contract.
- L. OWNER will require the use of prevailing wage rates on this Project. CONTRACTOR must comply with:
 - 1. Section 00450 - Prevailing Wage Rates, General Decision Number MI20200083, dated 05/08/2020.
 - 2. Section 00458 – Buy American Contract Language

ARTICLE 9 - CONTRACT DOCUMENTS

9.01 Contents

- A. The Contract Documents consist of the following:
 - 1. This Agreement (Pages 00500-1 to _____, inclusive);
 - 2. Performance Bond (Pages 00613-1 to 2, inclusive);
 - 3. Payment Bond (Pages 00614-1 to 2, inclusive);

4. General Conditions (Pages 00700-1 to _____, inclusive);
5. Supplementary Conditions (Pages 00800-1 to _____, inclusive);
6. Specifications as listed in the table of contents of the Project Manual;
7. Drawings consisting of a cover sheet and sheets enumerated as follows:

<u>Volume I</u>	<u>Drawing No.</u>	<u>Volume II</u>	<u>Drawing No.</u>
General	G-1 through _____, inclusive	Pipework	P-1 through _____, inclusive
Architectural	A-1 through _____, inclusive	Mechanical	M-1 through _____, inclusive
Structural	S-1 through _____, inclusive		

<u>Volume III</u>	<u>Drawing No.</u>
Electrical	E-1 through _____, inclusive
Instrumentation	I-1 through _____, inclusive

With each sheet bearing the following general title:

City of Flint
Water Pollution Control
Aeration System Improvements
SRF No. 5696-01
Contract 200-156238-19001

7. Addenda (numbers _____ to _____, inclusive);
 8. Exhibits to this Agreement (enumerated as follows):
 - a. Notice to Proceed (Page 00550-1);
 - b. CONTRACTOR's Bid (Pages 00400-1 to _____, inclusive);
 - c. Documentation submitted by CONTRACTOR prior to Notice of Award (pages _____ to _____, inclusive);
 - d. _____;
 9. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
 - a. Written Amendments;
 - b. Work Change Directives;
 - c. Change Order(s).
- B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 9.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 10 - MISCELLANEOUS

10.01 Terms

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

10.02 Assignment of Contract

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

10.03 Successors and Assigns

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

10.04 Severability

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

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in duplicate. One counterpart each has been delivered to OWNER and CONTRACTOR. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR or on their behalf.

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

OWNER:

By: _____

[CORPORATE SEAL]

Attest _____

Address for giving notices:

(If OWNER is a corporation, attach evidence of authority to sign. If OWNER is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of OWNER-CONTRACTOR Agreement.)

Designated Representative:

Name: _____

Title: _____

Address: _____

Phone: _____

Facsimile: _____

CONTRACTOR:

By: _____

[CORPORATE SEAL]

Attest _____

Address for giving notices:

License No. _____
(Where applicable)

Agent for service of process: _____

(If CONTRACTOR is a corporation or a partnership, attach evidence of authority to sign.)

Designated Representative:

Name: _____

Title: _____

Address: _____

Phone: _____

Facsimile: _____

END OF SECTION

NOTICE OF AWARD

Dated _____

TO: _____
(BIDDER)

ADDRESS: _____

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

Contract No. _____

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

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

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

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

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

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

1. Deliver to the ENGINEER ___ fully executed counterparts of the Contract Documents. (Each of the Contract Documents must bear your signature on Page ___ of Section 00500, Agreement.)

2. Deliver with the executed Contract Documents the Contract security (Bonds) and ten copies of all insurance certificates as specified in the Instructions to Bidders (Article 20), and General Conditions (Paragraphs 5.01, 5.03, 5.04, 5.05 and 5.06), as amended by the Supplementary.
3. Deliver to OWNER with copy to ENGINEER an acknowledged copy of this Notice of Award.
4. (List other conditions precedent).

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

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

(OWNER)

By: _____

(AUTHORIZED SIGNATURE)

(TITLE)

ACKNOWLEDGEMENT OF ACCEPTANCE OF NOTICE OF AWARD

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

(CONTRACTOR)

By: _____

(AUTHORIZED SIGNATURE)

(TITLE)

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

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

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NOTICE TO PROCEED

Dated _____

TO: _____
(CONTRACTOR)

ADDRESS: _____

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

Contract No. _____

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

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

(OWNER)

By: _____
(AUTHORIZED SIGNATURE)

(TITLE)

ACKNOWLEDGEMENT OF ACCEPTANCE OF NOTICE TO PROCEED

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

(CONTRACTOR)

By: _____
(AUTHORIZED SIGNATURE)

(TITLE)

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

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00550-1

052920

Performance Bond

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

CONTRACTOR (Name and Address):

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

OWNER (Name and Address):

CONTRACT

Date:

Amount:

Description (Name and Location):

BOND

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL

Company: (Corp. Seal)

Signature: _____

Name and Title:

SURETY

Company: (Corp. Seal)

Signature: _____

Name and Title:

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

CONTRACTOR AS PRINCIPAL

Company: (Corp. Seal)

Signature: _____

Name and Title:

SURETY

Company: (Corp. Seal)

Signature: _____

Name and Title:

EJCDC No. 1910-28-A (1996 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.

(FOR INFORMATION ONLY--Name, Address and Telephone)

AGENT or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

200-156238-19001

00613-1

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

2. If the CONTRACTOR performs the Contract, the Surety and the CONTRACTOR have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no OWNER Default, the Surety's obligation under this Bond shall arise after:

3.1. The OWNER has notified the CONTRACTOR and the Surety at the addresses described in Paragraph 10 below, that the OWNER is considering declaring a CONTRACTOR Default and has requested and attempted to arrange a conference with the CONTRACTOR and the Surety to be held not later than fifteen days after receipt of such notice to discuss methods of performing the Contract. If the OWNER, the CONTRACTOR and the Surety agree, the CONTRACTOR shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive the OWNER's right, if any, subsequently to declare a CONTRACTOR Default; and

3.2. The OWNER has declared a CONTRACTOR Default and formally terminated the CONTRACTOR's right to complete the Contract. Such CONTRACTOR Default shall not be declared earlier than twenty days after the CONTRACTOR and the Surety have received notice as provided in Paragraph 3.1; and

3.3. The OWNER has agreed to pay the Balance of the Contract Price to:

3.3.1. The Surety in accordance with the terms of the Contract;

3.3.2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When the OWNER has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

4.1. Arrange for the CONTRACTOR, with consent of the OWNER, to perform and complete the Contract; or

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

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the OWNER for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by the OWNER and the contractor selected with the OWNER's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to the OWNER the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by the OWNER resulting from the CONTRACTOR Default; or

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

4.4.1. After investigation, determine the amount for which it may be liable to the OWNER and, as soon as practicable after the amount is determined, tender payment therefor to the OWNER; or

4.4.2. Deny liability in whole or in part and notify the OWNER citing reasons therefor.

5. If the Surety does not proceed as provided in Paragraph 4 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fifteen days after receipt of an additional written notice from the OWNER to the Surety demanding that the Surety perform its obligations under this Bond, and the OWNER shall be entitled to enforce any remedy available to the OWNER. If the Surety proceeds as provided in Paragraph 4.4, and the OWNER refuses the payment tendered or the Surety has denied p liability, in whole or in part, without further notice the OWNER shall be entitled to enforce any remedy available to the OWNER.

6. After the OWNER has terminated the CONTRACTOR's right to complete the Contract, and if the Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of the Surety to the OWNER shall not be greater than those of the CONTRACTOR under the Contract, and the responsibilities of the OWNER to the Surety shall not be greater than those of the OWNER under the Contract. To a limit of the amount of this Bond, but subject to commitment by the OWNER of the Balance of the Contract Price to mitigation of costs and damages on the Contract, the Surety is obligated without duplication for:

6.1. The responsibilities of the CONTRACTOR for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional and delay costs resulting from the CONTRACTOR's Default, and resulting from the actions or failure to act of the Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of the CONTRACTOR.

7. The Surety shall not be liable to the OWNER or others for obligations of the CONTRACTOR that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the OWNER or its heirs, executors, administrators, or successors.

8. The Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after CONTRACTOR Default or within two years after the CONTRACTOR ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to the Surety, the OWNER or the CONTRACTOR shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by the OWNER to the CONTRACTOR under the Contract after all proper adjustments have been made, including allowance to the CONTRACTOR of any amounts received or to be received by the OWNER in settlement of insurance or other Claims for damages to which the CONTRACTOR is entitled, reduced by all valid and proper payments made to or on behalf of the CONTRACTOR under the Contract.

12.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

12.3. CONTRACTOR Default: Failure of the CONTRACTOR, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. OWNER Default: Failure of the OWNER, which has neither been remedied nor waived, to pay the CONTRACTOR as required by the Contract or to perform and complete or comply with the other terms thereof.

(FOR INFORMATION ONLY--Name, Address and Telephone)
AGENT or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00613-2

052920

Payment Bond

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

CONTRACTOR (Name and Address):

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

OWNER (Name and Address):

CONTRACT

Date:

Amount:

Description (Name and Location):

BOND

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL

Company: (Corp. Seal)

Signature: _____

Name and Title:

SURETY

Company: (Corp. Seal)

Signature: _____

Name and Title:

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

CONTRACTOR AS PRINCIPAL

Company: (Corp. Seal)

Signature: _____

Name and Title:

SURETY

Company: (Corp. Seal)

Signature: _____

Name and Title:

EJCDC No. 1910-28-B (1996 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

(FOR INFORMATION ONLY--Name, Address and Telephone)

AGENCY or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00614-1

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1. The CONTRACTOR and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the OWNER to pay for labor, materials and equipment furnished for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to the OWNER, this obligation shall be null and void if the CONTRACTOR:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies and holds harmless the OWNER from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Contract, provided the OWNER has promptly notified the CONTRACTOR and the Surety (at the addresses described in Paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands, liens or suits to the CONTRACTOR and the Surety, and provided there is no OWNER Default.

3. With respect to Claimants, this obligation shall be null and void if the CONTRACTOR promptly makes payment, directly or indirectly, for all sums due.

4. The Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with the CONTRACTOR have given notice to the Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with the CONTRACTOR:

1. Have furnished written notice to the CONTRACTOR and sent a copy, or notice thereof, to the OWNER, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from the CONTRACTOR, or not received within 30 days of furnishing the above notice any communication from the CONTRACTOR by which the CONTRACTOR had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to the Surety and sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the CONTRACTOR.

5. If a notice required by Paragraph 4 is given by the OWNER to the CONTRACTOR or to the Surety, that is sufficient compliance.

6. Reserved

7. The Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

8. Amounts owed by the OWNER to the CONTRACTOR under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any Performance Bond. By the CONTRACTOR furnishing and the OWNER accepting this Bond, they agree that all funds earned by the CONTRACTOR in the performance of the Contract are dedicated to satisfy obligations of the CONTRACTOR and the Surety under this Bond, subject to the OWNER's priority to use the funds for the completion of the Work.

9. The Surety shall not be liable to the OWNER, Claimants or others for obligations of the CONTRACTOR that are unrelated to the Contract. The OWNER shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. The Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the OWNER or the CONTRACTOR shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, the OWNER or the CONTRACTOR, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is, that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, the CONTRACTOR shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. DEFINITIONS

15.1. Claimant: An individual or entity having a direct contract with the CONTRACTOR or with a Subcontractor of the CONTRACTOR to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of the CONTRACTOR and the CONTRACTOR's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

15.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

15.3. OWNER Default: Failure of the OWNER, which has neither been remedied nor waived, to pay the CONTRACTOR as required by the Contract or to perform and complete or comply with the other terms thereof.

(FOR INFORMATION ONLY--Name, Address and Telephone)

AGENCY or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00614-2

052920

CONSTRUCTION CONTRACTS WITH CERTAIN PUBLIC AGENCIES
Act 524 of 1980

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

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

The People of the State of Michigan enact:

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

Sec. 1. As used in this act:

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

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

125.1562 Construction contract; designation of person to submit written requests for progress payments; designation of person to whom requests for progress payments to be submitted; manner and times of submissions; deferring the processing of progress payments; payment of requested

progress payment; failure of public agency to make timely progress payment; interest. [M.S.A. 5.2949(102)]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

City of Flint WPC

Aeration System Improvements

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

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

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

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

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

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

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

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

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

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

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

SECTION 00620 - APPLICATION FOR PAYMENT CERTIFICATE

CONTRACTOR'S APPLICATION FOR PAYMENT NO. _____

CONTRACTOR: _____ TITLE: _____

OWNER: _____ CONTRACT NO.: _____

Substantial Completion Date: _____ Final Completion Date: _____

Milestone Completion Date: _____

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

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

CONTRACTOR's Certification:

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

ATTACHMENTS TO THIS CERTIFICATION:

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

CONTRACTOR:

By: _____ Date: _____

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

By: _____ Date: _____

APPROVED: OWNER

By: _____ Date: _____

City of Flint WPC
Aeration System Improvements
SRF No. 5696-01
200-156238-19001

00620-1

052920

Change Order Summary

No.	Date	Additions	Deductions
	Subtotals		
Total Change In Contract Price			

SAMPLE

Stored Material Summary

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

SECTION 00623 - CERTIFICATES OF INSURANCE

Attach Certificates of Insurance to This Page.

SECTION 00625 - CERTIFICATE OF COMPONENT ACCEPTANCE

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

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

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

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

Manufacturer's Representative	Date	Signature
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Witnesses:

Owner's Representative	Date	Signature
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Contractor's Representative	Date	Signature
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Engineer's Representative	Date	Signature
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Owner	Date	Signature
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END OF SECTION

SECTION 00626 - CERTIFICATE OF SUBSTANTIAL COMPLETION

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

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

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

DATE OF SUBSTANTIAL COMPLETION

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

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

OWNER: Shall perform and/or maintain insurances, if any, in accordance with Article 5 of the General Conditions, and allow CONTRACTOR reasonable access to complete or correct items on the tentative list. Additional responsibilities are:

CONTRACTOR: Shall perform and/or maintain Site security, temporary facilities, Bonds and insurances in accordance with Article 5 of the General Conditions, and protect the Work. Additional responsibilities are:

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

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

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

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Substantial Completion on _____
Date

CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Substantial Completion on _____
Date

OWNER

By: _____
(Authorized Signature)

SECTION 00627 - CERTIFICATE OF FINAL COMPLETION

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

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

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, in accordance with Paragraph 14.06 of the General Conditions, and that Work is hereby declared to be finally complete in accordance with the Contract Documents on

DATE OF FINAL COMPLETION

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

CONTRACTOR's special warranty and guarantee are:

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

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

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

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Final Completion on _____
Date

CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Final Completion on _____
Date

OWNER

By: _____
(Authorized Signature)

SECTION 00700 - GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Contract Documents and printed with initial or all capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof.

1. *Addenda*--Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the Contract Documents.

2. *Agreement*--The written instrument which is evidence of the agreement between OWNER and CONTRACTOR covering the Work.

3. *Application for Payment*--The form acceptable to ENGINEER which is to be used by CONTRACTOR during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*--Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Bid*--The offer or proposal of a bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Bidding Documents*--The Bidding Requirements and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

7. *Bidding Requirements*--The Advertisement or Invitation to Bid, Instructions to Bidders, Bid security form, if any, and the Bid form with any supplements.

8. *Bonds*--Performance and payment bonds and other instruments of security.

9. *Change Order*--A document recommended by ENGINEER which is signed by CONTRACTOR and OWNER and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. *Claim*--A demand or assertion by OWNER or CONTRACTOR seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*--The entire and integrated written agreement between the OWNER and CONTRACTOR concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*--The Contract Documents establish the rights and obligations of the parties and include the Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid (including documentation accompanying the Bid and any post Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are more specifically identified in the Agreement, together with all Written Amendments, Change Orders, Work Change Directives, Field Orders, and ENGINEER's written interpretations and clarifications issued on or after the Effective Date of the Agreement. Approved Shop Drawings and the reports and drawings of subsurface and physical conditions are not Contract Documents. Only printed or hard copies of the items listed in this paragraph are Contract Documents. Files in electronic media format of text, data, graphics, and the like that may be furnished by OWNER to CONTRACTOR are not Contract Documents.

13. *Contract Price*--The moneys payable by OWNER to CONTRACTOR for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*--The number of days or the dates stated in the Agreement to: (i) achieve Substantial Completion; and (ii) complete the Work so that it is ready for final payment as evidenced by ENGINEER's written recommendation of final payment.

15. *CONTRACTOR*--The individual or entity with whom OWNER has entered into the Agreement.

16. *Cost of the Work*--See Paragraph 11.01.A for definition.

17. *Drawings*--That part of the Contract Documents prepared or approved by ENGINEER which

graphically shows the scope, extent, and character of the Work to be performed by CONTRACTOR. Shop Drawings and other CONTRACTOR submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

19. *ENGINEER*--The individual or entity named as such in the Agreement.

20. *ENGINEER's Consultant*--An individual or entity having a contract with ENGINEER to furnish services as ENGINEER's independent professional associate or consultant with respect to the Project and who is identified as such in the Supplementary Conditions.

21. *Field Order*--A written order issued by ENGINEER which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

22. *General Requirements*--Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

23. *Hazardous Environmental Condition*--The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

24. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

25. *Laws and Regulations; Laws or Regulations*--Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

26. *Liens*--Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

27. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

28. *Notice of Award*--The written notice by OWNER to the apparent successful bidder stating that upon timely compliance by the apparent successful bidder with the conditions precedent listed therein, OWNER will sign and deliver the Agreement.

29. *Notice to Proceed*--A written notice given by OWNER to CONTRACTOR fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform the Work under the Contract Documents.

30. *OWNER*--The individual, entity, public body, or authority with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be performed.

31. *Partial Utilization*--Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.

32. *PCBs*--Polychlorinated biphenyls.

33. *Petroleum*--Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

34. *Project*--The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part as may be indicated elsewhere in the Contract Documents.

35. *Project Manual*--The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

36. *Radioactive Material*--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

37. *Resident Project Representative*--The authorized representative of ENGINEER who may be assigned to the Site or any part thereof.

38. *Samples*--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

39. *Shop Drawings*--All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

40. *Site*--Lands or areas indicated in the Contract Documents as being furnished by OWNER upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by OWNER which are designated for the use of CONTRACTOR.

41. *Specifications*--That part of the Contract Documents consisting of written technical descriptions of materials, equipment, systems, standards, and workmanship as applied to the Work and certain administrative details applicable thereto.

42. *Subcontractor*--An individual or entity having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the Site.

43. *Substantial Completion*--The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of ENGINEER, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

44. *Supplementary Conditions*--That part of the Contract Documents which amends or supplements these General Conditions.

45. *Supplier*--A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.

46. *Underground Facilities*--All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

47. *Unit Price Work*--Work to be paid for on the basis of unit prices.

48. *Work*--The entire completed construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

49. *Work Change Directive*--A written statement to CONTRACTOR issued on or after the Effective Date of the Agreement and signed by OWNER and recommended by ENGINEER ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

50. *Written Amendment*--A written statement modifying the Contract Documents, signed by OWNER and CONTRACTOR on or after the Effective Date of the Agreement and normally dealing with the nonengineering or nontechnical rather than strictly construction-related aspects of the Contract Documents.

1.02 Terminology

A. Intent of Certain Terms or Adjectives

1. Whenever in the Contract Documents the terms "as allowed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of ENGINEER as to the Work, it is intended that such action or determination will be solely to evaluate, in general, the completed Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to ENGINEER any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to

the provisions of Paragraph 9.10 or any other provision of the Contract Documents.

B. *Day*

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

C. *Defective*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it does not conform to the Contract Documents or does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents, or has been damaged prior to ENGINEER’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

D. *Furnish, Install, Perform, Provide*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of CONTRACTOR, “provide” is implied.

E. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 *Delivery of Bonds*

A. When CONTRACTOR delivers the executed Agreements to OWNER, CONTRACTOR shall also deliver to OWNER such Bonds as CONTRACTOR may be required to furnish.

2.02 *Copies of Documents*

A. OWNER shall furnish to CONTRACTOR up to ten copies of the Contract Documents. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.04 *Starting the Work*

A. CONTRACTOR shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *CONTRACTOR’s Review of Contract Documents:* Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. CONTRACTOR shall promptly report in writing to ENGINEER any conflict, error, ambiguity, or discrepancy which CONTRACTOR may discover and shall obtain a written interpretation or clarification from ENGINEER before proceeding with any Work affected thereby; however, CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless CONTRACTOR knew or reasonably should have known thereof.

B. *Preliminary Schedules:* Within ten days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), CONTRACTOR shall submit to ENGINEER for its timely review:

1. a preliminary progress schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary schedule of Shop Drawing and Sample submittals which will list each required submittal and the times for submitting, reviewing, and processing such submittal; and

3. a preliminary schedule of values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

C. *Evidence of Insurance:* Before any Work at the Site is started, CONTRACTOR and OWNER shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which CONTRACTOR and OWNER respectively are required to purchase and maintain in accordance with Article 5.

2.06 *Preconstruction Conference*

A. Within 20 days after the Contract Times start to run, but before any Work at the Site is started, a conference attended by CONTRACTOR, ENGINEER, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.B, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.07 *Initial Acceptance of Schedules*

A. Unless otherwise provided in the Contract Documents, at least ten days before submission of the first Application for Payment a conference attended by CONTRACTOR, ENGINEER, and others as appropriate

will be held to review for acceptability to ENGINEER as provided below the schedules submitted in accordance with Paragraph 2.05.B. CONTRACTOR shall have an additional ten days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to CONTRACTOR until acceptable schedules are submitted to ENGINEER.

1. The progress schedule will be acceptable to ENGINEER if it provides an orderly progression of the Work to completion within any specified Milestones and the Contract Times. Such acceptance will not impose on ENGINEER responsibility for the progress schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.

2. CONTRACTOR's schedule of Shop Drawing and Sample submittals will be acceptable to ENGINEER if it provides a workable arrangement for reviewing and processing the required submittals.

3. CONTRACTOR's schedule of values will be acceptable to ENGINEER as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to OWNER.

C. Clarifications and interpretations of the Contract Documents shall be issued by ENGINEER as provided in Article 9.

3.02 *Reference Standards*

A. *Standards, Specifications, Codes, Laws, and Regulations*

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of OWNER, CONTRACTOR, or ENGINEER, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall any such provision or instruction be effective to assign to OWNER, ENGINEER, or any of ENGINEER's Consultants, agents, or employees any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, CONTRACTOR shall report it to ENGINEER in writing at once. CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04; provided, however, that CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any such conflict, error, ambiguity, or discrepancy unless CONTRACTOR knew or reasonably should have known thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways: (i) a Written Amendment; (ii) a Change Order; or (iii) a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways: (i) a Field Order; (ii) ENGINEER's approval of a Shop Drawing or Sample; or (iii) ENGINEER's written interpretation or clarification.

3.05 *Reuse of Documents*

A. CONTRACTOR and any Subcontractor or Supplier or other individual or entity performing or furnishing any of the Work under a direct or indirect contract with OWNER: (i) shall not have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER or ENGINEER's Consultant, including electronic media editions; and (ii) shall not reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaption by ENGINEER. This prohibition will survive final payment, completion, and acceptance of the Work, or termination or completion of the Contract. Nothing herein shall preclude

CONTRACTOR from retaining copies of the Contract Documents for record purposes.

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

4.01 *Availability of Lands*

A. OWNER shall furnish the Site. OWNER shall notify CONTRACTOR of any encumbrances or restrictions not of general application but specifically related to use of the Site with which CONTRACTOR must comply in performing the Work. OWNER will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If CONTRACTOR and OWNER are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in OWNER's furnishing the Site, CONTRACTOR may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, OWNER shall furnish CONTRACTOR with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and OWNER's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports of explorations and tests of subsurface conditions at or contiguous to the Site that ENGINEER has used in preparing the Contract Documents; and
2. those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that ENGINEER has used in preparing the Contract Documents.

B. *Limited Reliance by CONTRACTOR on Technical Data Authorized:* CONTRACTOR may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," CONTRACTOR may not rely upon or make any Claim against OWNER, ENGINEER, or any of ENGINEER's Consultants with respect to:

1. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by CONTRACTOR, and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any CONTRACTOR interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If CONTRACTOR believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:

1. is of such a nature as to establish that any "technical data" on which CONTRACTOR is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
2. is of such a nature as to require a change in the Contract Documents; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify OWNER and ENGINEER in writing about such condition. CONTRACTOR shall not

further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *ENGINEER's Review:* After receipt of written notice as required by Paragraph 4.03.A, ENGINEER will promptly review the pertinent condition, determine the necessity of OWNER's obtaining additional exploration or tests with respect thereto, and advise OWNER in writing (with a copy to CONTRACTOR) of ENGINEER's findings and conclusions.

C. *Possible Price and Times Adjustments*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in CONTRACTOR's cost of, or time required for, performance of the Work; subject, however, to the following:

a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

b. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.08 and 11.03.

2. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Contract Times if:

a. CONTRACTOR knew of the existence of such conditions at the time CONTRACTOR made a final commitment to OWNER in respect of Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR's making such final commitment; or

c. CONTRACTOR failed to give the written notice within the time and as required by Paragraph 4.03.A.

3. If OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, OWNER, ENGINEER, and ENGINEER's Consultants shall not be liable to CONTRACTOR for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by CONTRACTOR on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to OWNER or ENGINEER by the owners of such Underground Facilities, including OWNER, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. OWNER and ENGINEER shall not be responsible for the accuracy or completeness of any such information or data; and

2. the cost of all of the following will be included in the Contract Price, and CONTRACTOR shall have full responsibility for:

a. reviewing and checking all such information and data,

b. locating all Underground Facilities shown or indicated in the Contract Documents,

c. coordination of the Work with the owners of such Underground Facilities, including OWNER, during construction, and

d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract

Documents, CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to OWNER and ENGINEER. ENGINEER will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility.

2. If ENGINEER concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price of Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that CONTRACTOR did not know of and could not reasonably have been expected to be aware of or to have anticipated. If OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, OWNER or CONTRACTOR may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

A. OWNER shall provide engineering surveys to establish reference points for construction which in ENGINEER's judgment are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

A. *Reports and Drawings:* Reference is made to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the ENGINEER in the preparation of the Contract Documents.

B. *Limited Reliance by CONTRACTOR on Technical Data Authorized:* CONTRACTOR may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," CONTRACTOR may not rely upon or make any Claim against OWNER, ENGINEER or any of ENGINEER's Consultants with respect to:

1. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
3. any CONTRACTOR interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

C. CONTRACTOR shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. CONTRACTOR shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by CONTRACTOR, Subcontractors, Suppliers, or anyone else for whom CONTRACTOR is responsible.

D. If CONTRACTOR encounters a Hazardous Environmental Condition or if CONTRACTOR or anyone for whom CONTRACTOR is responsible creates a Hazardous Environmental Condition, CONTRACTOR shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16); and (iii) notify OWNER and ENGINEER (and promptly thereafter

confirm such notice in writing). OWNER shall promptly consult with ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such condition or take corrective action, if any.

E. CONTRACTOR shall not be required to resume Work in connection with such condition or in any affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If OWNER and CONTRACTOR cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by CONTRACTOR, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then OWNER may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If OWNER and CONTRACTOR cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. OWNER may have such deleted portion of the Work performed by OWNER's own forces or others in accordance with Article 7.

G. To the fullest extent permitted by Laws and Regulations, OWNER shall indemnify and hold harmless CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and the officers, directors, partners, employees, agents, other consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by CONTRACTOR or by anyone for whom CONTRACTOR is responsible. Nothing in this Paragraph 4.06.E shall obligate OWNER to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

H. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants, and the officers, directors, partners, employees, agents, other consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by CONTRACTOR or by anyone for whom CONTRACTOR is responsible. Nothing in this Paragraph 4.06.F shall obligate CONTRACTOR to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 are not intended to apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 - BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. CONTRACTOR shall furnish performance and payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date when final payment becomes due, except as provided otherwise by Laws or Regulations or by the Contract Documents. CONTRACTOR shall also furnish such other Bonds as are required by the Contract Documents.

B. All Bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

C. If the surety on any Bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the

requirements of Paragraph 5.01.B, CONTRACTOR shall within 20 days thereafter substitute another Bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

A. All Bonds and insurance required by the Contract Documents to be purchased and maintained by OWNER or CONTRACTOR shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue Bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

A. CONTRACTOR shall deliver to OWNER, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by OWNER or any other additional insured) which CONTRACTOR is required to purchase and maintain. OWNER shall deliver to CONTRACTOR, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by CONTRACTOR or any other additional insured) which OWNER is required to purchase and maintain.

5.04 *CONTRACTOR's Liability Insurance*

A. CONTRACTOR shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from CONTRACTOR's performance of the Work and CONTRACTOR's other obligations under the Contract Documents, whether it is to be performed by CONTRACTOR, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;
2. claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained: (i) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR, or (ii) by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance so required by this Paragraph 5.04 to be purchased and maintained shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insureds (subject to any customary exclusion in respect of professional liability) OWNER, ENGINEER, ENGINEER's Consultants, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering CONTRACTOR's indemnity obligations under Paragraphs 6.07, 6.11, and 6.20;

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least

thirty days prior written notice has been given to OWNER and CONTRACTOR and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the CONTRACTOR pursuant to Paragraph 5.03 will so provide);

6. remain in effect at least until final payment and at all times thereafter when CONTRACTOR may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and CONTRACTOR shall furnish OWNER and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to OWNER and any such additional insured of continuation of such insurance at final payment and one year thereafter).

5.05 *OWNER's Liability Insurance*

A. In addition to the insurance required to be provided by CONTRACTOR under Paragraph 5.04, OWNER, at OWNER's option, may purchase and maintain at OWNER's expense OWNER's own liability insurance as will protect OWNER against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

A. Unless otherwise provided in the Supplementary Conditions, OWNER shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

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

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

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

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

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

6. include testing and startup; and

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

B. OWNER shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants, and any other individuals or entities identified in the Supplementary Conditions, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to OWNER and CONTRACTOR and to each other additional

insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. OWNER shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of CONTRACTOR, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by CONTRACTOR, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

E. If CONTRACTOR requests in writing that other special insurance be included in the property insurance policies provided under Paragraph 5.06, OWNER shall, if possible, include such insurance, and the cost thereof will be charged to CONTRACTOR by appropriate Change Order or Written Amendment. Prior to commencement of the Work at the Site, OWNER shall in writing advise CONTRACTOR whether or not such other insurance has been procured by OWNER.

5.07 *Waiver of Rights*

A. OWNER and CONTRACTOR intend that all policies purchased in accordance with Paragraph 5.06 will protect OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. OWNER and CONTRACTOR waive all rights against each other and their respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, ENGINEER, ENGINEER's Consultants, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of

them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by OWNER as trustee or otherwise payable under any policy so issued.

B. OWNER waives all rights against CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants, and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to OWNER's property or the Work caused by, arising out of, or resulting from fire or other peril whether or not insured by OWNER; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by OWNER during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by OWNER covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against CONTRACTOR, Subcontractors, ENGINEER, or ENGINEER's Consultants and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with OWNER and made payable to OWNER as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. OWNER shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order or Written Amendment.

B. OWNER as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to OWNER's exercise of this power. If such objection be made, OWNER as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, OWNER as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, OWNER as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either OWNER or CONTRACTOR has any objection to the coverage afforded by or other provisions of the Bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of nonconformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.05.C. OWNER and CONTRACTOR shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the Bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent Bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If OWNER finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. CONTRACTOR shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction, but CONTRACTOR shall not be responsible for the negligence of OWNER or ENGINEER in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents. CONTRACTOR shall be responsible to see that the completed Work complies accurately with the Contract Documents.

B. At all times during the progress of the Work, CONTRACTOR shall assign a competent resident superintendent thereto who shall not be replaced without written notice to OWNER and ENGINEER except under extraordinary circumstances. The superintendent will be CONTRACTOR's representative at the Site and shall have authority to act on behalf of CONTRACTOR. All communications given to or received from the superintendent shall be binding on CONTRACTOR.

6.02 *Labor; Working Hours*

A. CONTRACTOR shall provide competent, suitably qualified personnel to survey, lay out, and construct the Work as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, and CONTRACTOR will not permit overtime work or the performance of Work on Saturday, Sunday, or any legal holiday without OWNER's written consent (which will not be unreasonably withheld) given after prior written notice to ENGINEER.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the General Requirements, CONTRACTOR shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and

machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of OWNER. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. CONTRACTOR shall adhere to the progress schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. CONTRACTOR shall submit to ENGINEER for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the progress schedule that will not result in changing the Contract Times (or Milestones). Such adjustments will conform generally to the progress schedule then in effect and additionally will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the progress schedule that will change the Contract Times (or Milestones) shall be submitted in accordance with the requirements of Article 12. Such adjustments may only be made by a Change Order or Written Amendment in accordance with Article 12.

6.05 *Substitutes and "Or-Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other

Suppliers may be submitted to ENGINEER for review under the circumstances described below.

1. *"Or-Equal" Items:* If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER as an "or-equal" item, in which case review and approval of the proposed item may, in ENGINEER's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment ENGINEER determines that: (i) it is at least equal in quality, durability, appearance, strength, and design characteristics; (ii) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole, and;

b. CONTRACTOR certifies that: (i) there is no increase in cost to the OWNER; and (ii) it will conform substantially, even with deviations, to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items*

a. If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. CONTRACTOR shall submit sufficient information as provided below to allow ENGINEER to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by ENGINEER from anyone other than CONTRACTOR.

c. The procedure for review by ENGINEER will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as ENGINEER may decide is appropriate under the circumstances.

d. CONTRACTOR shall first make written application to ENGINEER for review of a proposed substitute item of material or equipment that CONTRACTOR seeks to furnish or use. The application shall certify that the proposed substitute item will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified, and be suited to the same use as that specified. The application will state the extent, if any, to which the use of the proposed substitute item will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) to adapt the design to the proposed substitute item and whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute item from that specified will be identified in the application, and available engineering, sales, maintenance, repair, and replacement services will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change, all of which will be considered by ENGINEER in evaluating the proposed substitute item. ENGINEER may require CONTRACTOR to furnish additional data about the proposed substitute item.

B. Substitute Construction Methods or Procedures:

If a specific means, method, technique, sequence, or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by ENGINEER. CONTRACTOR shall submit sufficient information to allow ENGINEER, in ENGINEER's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by ENGINEER will be similar to that provided in Subparagraph 6.05.A.2.

C. Engineer's Evaluation: ENGINEER will be allowed a reasonable time within which to evaluate each

proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. ENGINEER will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized until ENGINEER's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." ENGINEER will advise CONTRACTOR in writing of any negative determination.

D. Special Guarantee: OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any substitute.

E. ENGINEER's Cost Reimbursement: ENGINEER will record time required by ENGINEER and ENGINEER's Consultants in evaluating substitute proposed or submitted by CONTRACTOR pursuant to Paragraphs 6.05.A.2 and 6.05.B and in making changes in the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) occasioned thereby. Whether or not ENGINEER approves a substitute item so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's Consultants for evaluating each such proposed substitute.

F. CONTRACTOR's Expense: CONTRACTOR shall provide all data in support of any proposed substitute or "or-equal" at CONTRACTOR's expense.

6.06 Concerning Subcontractors, Suppliers, and Others

A. CONTRACTOR shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to OWNER as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom OWNER may have reasonable objection. CONTRACTOR shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to OWNER in advance for acceptance by OWNER by a specified date prior to the Effective Date of the Agreement, and if CONTRACTOR has submitted a list thereof in accordance with the Supplementary Conditions, OWNER's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity

so identified may be revoked on the basis of reasonable objection after due investigation. CONTRACTOR shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued or Written Amendment signed. No acceptance by OWNER of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of OWNER or ENGINEER to reject defective Work.

C. CONTRACTOR shall be fully responsible to OWNER and ENGINEER for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as CONTRACTOR is responsible for CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between OWNER or ENGINEER and any such Subcontractor, Supplier or other individual or entity, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR.

E. CONTRACTOR shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with ENGINEER through CONTRACTOR.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for CONTRACTOR by a Subcontractor or Supplier will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of OWNER and ENGINEER. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in

Paragraph 5.06, the agreement between the CONTRACTOR and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against OWNER, CONTRACTOR, ENGINEER, ENGINEER's Consultants, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, CONTRACTOR will obtain the same.

6.07 *Patent Fees and Royalties*

A. CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of OWNER or ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants, and the officers, directors, partners, employees or agents, and other consultants of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of

opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. CONTRACTOR shall pay all charges of utility owners for connections to the Work, and OWNER shall pay all charges of such utility owners for capital costs related thereto, such as plant investment fees.

6.09 *Laws and Regulations*

A. CONTRACTOR shall give all notices and comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither OWNER nor ENGINEER shall be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations.

B. If CONTRACTOR performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, CONTRACTOR shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work; however, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve CONTRACTOR of CONTRACTOR's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work may be the subject of an adjustment in Contract Price or Contract Times. If OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

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

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations,

and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultant, and the officers, directors, partners, employees, agents, and other consultants of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against OWNER, ENGINEER, or any other party indemnified hereunder to the extent caused by or based upon CONTRACTOR's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work CONTRACTOR shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work CONTRACTOR shall clean the Site and make it ready for utilization by OWNER. At the completion of the Work CONTRACTOR shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

A. CONTRACTOR shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Written Amendments, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to ENGINEER for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to ENGINEER for OWNER.

6.13 *Safety and Protection*

A. CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. CONTRACTOR shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. All damage, injury, or loss to any property referred to in paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or

omissions of OWNER or ENGINEER or ENGINEER's Consultant, or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them). CONTRACTOR's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to OWNER and CONTRACTOR in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

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

6.15 *Hazard Communication Programs*

A. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, CONTRACTOR is obligated to act to prevent threatened damage, injury, or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If ENGINEER determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. CONTRACTOR shall submit Shop Drawings to ENGINEER for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals. All submittals will be identified as ENGINEER may require and in the number of copies specified in the General Requirements. The data shown on the Shop

Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show ENGINEER the services, materials, and equipment CONTRACTOR proposes to provide and to enable ENGINEER to review the information for the limited purposes required by Paragraph 6.17.E.

B. CONTRACTOR shall also submit Samples to ENGINEER for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalog numbers, and the use for which intended and otherwise as ENGINEER may require to enable ENGINEER to review the submittal for the limited purposes required by Paragraph 6.17.E. The numbers of each Sample to be submitted will be as specified in the Specifications.

C. Where a Shop Drawing or Sample is required by the Contract Documents or the schedule of Shop Drawings and Sample submittals acceptable to ENGINEER as required by Paragraph 2.07, any related Work performed prior to ENGINEER's review and approval of the pertinent submittal will be at the sole expense and responsibility of CONTRACTOR.

D. *Submittal Procedures*

1. Before submitting each Shop Drawing or Sample, CONTRACTOR shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

b. all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;

c. all information relative to means, methods, techniques, sequences, and procedures of construction and safety precautions and programs incident thereto; and

d. CONTRACTOR shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

2. Each submittal shall bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents with respect to CONTRACTOR's review and approval of that submittal.

3. At the time of each submittal, CONTRACTOR shall give ENGINEER specific written notice of such variations, if any, that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, such notice to be in a written communication separate from the submittal; and, in addition, shall cause a specific notation to be made on each Shop Drawing and Sample submitted to ENGINEER for review and approval of each such variation.

E. *ENGINEER's Review*

1. ENGINEER will timely review and approve Shop Drawings and Samples in accordance with the schedule of Shop Drawings and Sample submittals acceptable to ENGINEER. ENGINEER's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. ENGINEER's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. ENGINEER's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of each submittal as required by Paragraph 6.17.D.3 and ENGINEER has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER

relieve CONTRACTOR from responsibility for complying with the requirements of Paragraph 6.17.D.1.

F. *Resubmittal Procedures*

1. CONTRACTOR shall make corrections required by ENGINEER and shall return the required number of corrected copies of Shop Drawings and submit as required new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous submittals.

6.18 *Continuing the Work*

A. CONTRACTOR shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as OWNER and CONTRACTOR may otherwise agree in writing.

6.19 *CONTRACTOR's General Warranty and Guarantee*

A. CONTRACTOR warrants and guarantees to OWNER, ENGINEER, and ENGINEER's Consultants that all Work will be in accordance with the Contract Documents and will not be defective. CONTRACTOR's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than CONTRACTOR, Subcontractors, Suppliers, or any other individual or entity for whom CONTRACTOR is responsible; or

2. normal wear and tear under normal usage.

B. CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents:

1. observations by ENGINEER;

2. recommendation by ENGINEER or payment by OWNER of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by ENGINEER or any payment related thereto by OWNER;

4. use or occupancy of the Work or any part thereof by OWNER;

5. any acceptance by OWNER or any failure to do so;

6. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by ENGINEER;

7. any inspection, test, or approval by others; or

8. any correction of defective Work by OWNER.

6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants, and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage:

1. is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom; and

2. is caused in whole or in part by any negligent act or omission of CONTRACTOR, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not caused in part by any negligence or omission of an individual or entity indemnified hereunder or whether liability is imposed upon such indemnified party by Laws and Regulations

regardless of the negligence of any such individual or entity.

B. In any and all claims against OWNER or ENGINEER or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of CONTRACTOR, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for CONTRACTOR or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of CONTRACTOR under Paragraph 6.20.A shall not extend to the liability of ENGINEER and ENGINEER's Consultants or to the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

ARTICLE 7 - OTHER WORK

7.01 *Related Work at Site*

A. OWNER may perform other work related to the Project at the Site by OWNER's employees, or let other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to CONTRACTOR prior to starting any such other work; and
2. if OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a

result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. CONTRACTOR shall afford each other contractor who is a party to such a direct contract and each utility owner (and OWNER, if OWNER is performing the other work with OWNER's employees) proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work and shall properly coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, CONTRACTOR shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and the others whose work will be affected. The duties and responsibilities of CONTRACTOR under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between OWNER and such utility owners and other contractors.

C. If the proper execution or results of any part of CONTRACTOR's Work depends upon work performed by others under this Article 7, CONTRACTOR shall inspect such other work and promptly report to ENGINEER in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of CONTRACTOR's Work. CONTRACTOR's failure to so report will constitute an acceptance of such other work as fit and proper for integration with CONTRACTOR's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

A. If OWNER intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
2. the specific matters to be covered by such authority and responsibility will be itemized; and
3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, OWNER shall have sole authority and responsibility for such coordination.

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, OWNER shall issue all communications to CONTRACTOR through ENGINEER.

8.02 *Replacement of ENGINEER*

A. In case of termination of the employment of ENGINEER, OWNER shall appoint an engineer to whom CONTRACTOR makes no reasonable objection, whose status under the Contract Documents shall be that of the former ENGINEER.

8.03 *Furnish Data*

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

8.04 *Pay Promptly When Due*

A. OWNER shall make payments to CONTRACTOR promptly when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. OWNER's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to OWNER's identifying and making available to CONTRACTOR copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by ENGINEER in preparing the Contract Documents.

8.06 *Insurance*

A. OWNER's responsibilities, if any, in respect of purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

A. OWNER is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. OWNER's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on OWNER's Responsibilities*

A. The OWNER shall not supervise, direct, or have control or authority over, nor be responsible for, CONTRACTOR's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the performance of the Work. OWNER will not be responsible for CONTRACTOR's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. OWNER's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

A. If and to the extent OWNER has agreed to furnish CONTRACTOR reasonable evidence that financial arrangements have been made to satisfy OWNER's obligations under the Contract Documents, OWNER's responsibility in respect thereof will be as set forth in the Supplementary Conditions.

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *OWNER'S Representative*

A. ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER's representative during construction are set forth in the Contract Documents and will not be changed without written consent of OWNER and ENGINEER.

9.02 *Visits to Site*

A. ENGINEER will make visits to the Site at intervals appropriate to the various stages of construction as ENGINEER deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of CONTRACTOR's executed Work. Based on information obtained during such visits and observations, ENGINEER, for the benefit of OWNER, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. ENGINEER's efforts will be directed toward providing for OWNER a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against defective Work.

B. ENGINEER's visits and observations are subject to all the limitations on ENGINEER's authority and responsibility set forth in Paragraph 9.10, and particularly, but without limitation, during or as a result of ENGINEER's visits or observations of CONTRACTOR's Work ENGINEER will not supervise, direct, control, or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If OWNER and ENGINEER agree, ENGINEER will furnish a Resident Project Representative to assist ENGINEER in providing more extensive observation of the Work. The responsibilities and authority and limitations thereon of any such Resident Project Representative and assistants will be as provided in Paragraph 9.10 and in the Supplementary Conditions. If OWNER designates another representative or agent to represent OWNER at the Site who is not ENGINEER's Consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Clarifications and Interpretations*

A. ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents as ENGINEER may determine necessary, which shall be

consistent with the intent of and reasonably inferable from the Contract Documents. Such written clarifications and interpretations will be binding on OWNER and CONTRACTOR. If OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a written clarification or interpretation, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Authorized Variations in Work*

A. ENGINEER may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on OWNER and also on CONTRACTOR, who shall perform the Work involved promptly. If OWNER and CONTRACTOR are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of a Field Order, a Claim may be made therefor as provided in Paragraph 10.05.

9.06 *Rejecting Defective Work*

A. ENGINEER will have authority to disapprove or reject Work which ENGINEER believes to be defective, or that ENGINEER believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. ENGINEER will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.07 *Shop Drawings, Change Orders and Payments*

A. In connection with ENGINEER's authority as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with ENGINEER's authority as to Change Orders, see Articles 10, 11, and 12.

C. In connection with ENGINEER's authority as to Applications for Payment, see Article 14.

9.08 *Determinations for Unit Price Work*

A. ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by

CONTRACTOR. ENGINEER will review with CONTRACTOR the ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). ENGINEER's written decision thereon will be final and binding (except as modified by ENGINEER to reflect changed factual conditions or more accurate data) upon OWNER and CONTRACTOR, subject to the provisions of Paragraph 10.05.

9.09 Decisions on Requirements of Contract Documents and Acceptability of Work

A. ENGINEER will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. Claims, disputes and other matters relating to the acceptability of the Work, the quantities and classifications of Unit Price Work, the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, and Claims seeking changes in the Contract Price or Contract Times will be referred initially to ENGINEER in writing, in accordance with the provisions of Paragraph 10.05, with a request for a formal decision.

B. When functioning as interpreter and judge under this Paragraph 9.09, ENGINEER will not show partiality to OWNER or CONTRACTOR and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity. The rendering of a decision by ENGINEER pursuant to this Paragraph 9.09 with respect to any such Claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 14.07) will be a condition precedent to any exercise by OWNER or CONTRACTOR of such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such Claim, dispute, or other matter.

9.10 Limitations on ENGINEER's Authority and Responsibilities

A. Neither ENGINEER's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by ENGINEER shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by ENGINEER to CONTRACTOR, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. ENGINEER will not supervise, direct, control, or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the performance of the Work. ENGINEER will not be responsible for CONTRACTOR's failure to perform the Work in accordance with the Contract Documents.

C. ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. ENGINEER's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.10 shall also apply to ENGINEER's Consultants, Resident Project Representative, and assistants.

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

10.01 Authorized Changes in the Work

A. Without invalidating the Agreement and without notice to any surety, OWNER may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Written Amendment, a Change Order, or a Work Change Directive. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If OWNER and CONTRACTOR are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

A. CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 *Execution of Change Orders*

A. OWNER and CONTRACTOR shall execute appropriate Change Orders recommended by ENGINEER (or Written Amendments) covering:

1. changes in the Work which are: (i) ordered by OWNER pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or OWNER's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by ENGINEER pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, CONTRACTOR shall carry on the Work and adhere to the progress schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be CONTRACTOR's responsibility. The amount of each applicable Bond will be adjusted to reflect the effect of any such change.

10.05 *Claims and Disputes*

A. *Notice:* Written notice stating the general nature of each Claim, dispute, or other matter shall be delivered by the claimant to ENGINEER and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. Notice of the amount or extent of the Claim, dispute, or other matter with supporting data shall be delivered to the ENGINEER and the other party to the Contract within 60 days after the start of such event (unless ENGINEER allows additional time for claimant to submit additional or more accurate data in support of such Claim, dispute, or other matter). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to ENGINEER and the claimant within 30 days after receipt of the claimant's last submittal (unless ENGINEER allows additional time).

B. *ENGINEER's Decision:* ENGINEER will render a formal decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any. ENGINEER's written decision on such Claim, dispute, or other matter will be final and binding upon OWNER and CONTRACTOR unless:

1. an appeal from ENGINEER's decision is taken within the time limits and in accordance with the dispute resolution procedures set forth in Article 16; or

2. if no such dispute resolution procedures have been set forth in Article 16, a written notice of intention to appeal from ENGINEER's written decision is delivered by OWNER or CONTRACTOR to the other and to ENGINEER within 30 days after the date of such decision, and a formal proceeding is instituted by the appealing party in a forum of competent jurisdiction within 60 days after the date of such decision or within 60 days after Substantial Completion, whichever is later (unless otherwise agreed in writing by OWNER and CONTRACTOR), to exercise such rights or remedies as the appealing party may have with respect to such Claim, dispute, or other matter in accordance with applicable Laws and Regulations.

C. If ENGINEER does not render a formal decision in writing within the time stated in Paragraph 10.05.B, a decision denying the Claim in its entirety shall be deemed to have been issued 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

D. No Claim for an adjustment in Contract Price or Contract Times (or Milestones) will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 - COST OF THE WORK; CASH ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

A. *Costs Included:* The term Cost of the Work means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to CONTRACTOR will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.01.B.

1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Such employees shall include without limitation superintendents, foremen, and other personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by OWNER.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.

3. Payments made by CONTRACTOR to Subcontractors for Work performed by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from subcontractors acceptable to OWNER and CONTRACTOR and shall deliver such bids to OWNER, who will then determine, with the advice of ENGINEER, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as CONTRACTOR's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

a. The proportion of necessary transportation, travel, and subsistence expenses of CONTRACTOR's employees incurred in discharge of duties connected with the Work.

b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of CONTRACTOR.

c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from CONTRACTOR or others in accordance with

rental agreements approved by OWNER with the advice of ENGINEER, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expressage, and similar petty cash items in connection with the Work.

i. When the Cost of the Work is used to determine the value of a Change Order or of a Claim, the cost of premiums for additional Bonds and insurance required because of the changes in the Work or caused by the event giving rise to the Claim.

j. When all the Work is performed on the basis of cost-plus, the costs of premiums for all Bonds and insurance CONTRACTOR is required by the Contract Documents to purchase and maintain.

B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnerships and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by CONTRACTOR, whether at the Site or in CONTRACTOR's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the CONTRACTOR's fee.

2. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the Site.

3. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.

4. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

C. *CONTRACTOR's Fee:* When all the Work is performed on the basis of cost-plus, CONTRACTOR's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, CONTRACTOR's fee shall be determined as set forth in Paragraph 12.01.C.

D. *Documentation*: Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, CONTRACTOR will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to ENGINEER an itemized cost breakdown together with supporting data.

11.02 *Cash Allowances*

A. It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums as may be acceptable to OWNER and ENGINEER. CONTRACTOR agrees that:

1. the allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. CONTRACTOR's costs for unloading and handling on the Site, labor, installation costs, overhead, profit, and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

B. Prior to final payment, an appropriate Change Order will be issued as recommended by ENGINEER to reflect actual amounts due CONTRACTOR on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by CONTRACTOR will be made by ENGINEER subject to the provisions of Paragraph 9.08.

B. Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to

cover CONTRACTOR's overhead and profit for each separately identified item.

C. OWNER or CONTRACTOR may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by CONTRACTOR differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect any other item of Work; and

3. if CONTRACTOR believes that CONTRACTOR is entitled to an increase in Contract Price as a result of having incurred additional expense or OWNER believes that OWNER is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order or by a Written Amendment. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the ENGINEER and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a CONTRACTOR's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *CONTRACTOR's Fee*: The CONTRACTOR's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the CONTRACTOR's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the CONTRACTOR's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and CONTRACTOR will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by CONTRACTOR to OWNER for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in CONTRACTOR's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in CONTRACTOR's fee shall be computed on the basis of the net change in accordance with

Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times (or Milestones) may only be changed by a Change Order or by a Written Amendment. Any Claim for an adjustment in the Contract Times (or Milestones) shall be based on written notice submitted by the party making the claim to the ENGINEER and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times (or Milestones) covered by a Change Order or of any Claim for an adjustment in the Contract Times (or Milestones) will be determined in accordance with the provisions of this Article 12.

12.03 *Delays Beyond CONTRACTOR's Control*

A. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of CONTRACTOR, the Contract Times (or Milestones) will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by OWNER, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

12.04 *Delays Within CONTRACTOR's Control*

A. The Contract Times (or Milestones) will not be extended due to delays within the control of CONTRACTOR. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of CONTRACTOR.

12.05 *Delays Beyond OWNER's and CONTRACTOR's Control*

A. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of both OWNER and CONTRACTOR, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be CONTRACTOR's sole and exclusive remedy for such delay.

12.06 *Delay Damages*

A. In no event shall OWNER or ENGINEER be liable to CONTRACTOR, any Subcontractor, any Supplier, or any other person or organization, or to any surety for or employee or agent of any of them, for damages arising out of or resulting from:

1. delays caused by or within the control of CONTRACTOR; or
2. delays beyond the control of both OWNER and CONTRACTOR including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, or acts or neglect by utility owners or other contractors performing other work as contemplated by Article 7.

B. Nothing in this Paragraph 12.06 bars a change in Contract Price pursuant to this Article 12 to compensate CONTRACTOR due to delay, interference, or disruption directly attributable to actions or inactions of OWNER or anyone for whom OWNER is responsible.

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

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which OWNER or ENGINEER has actual knowledge will be given to CONTRACTOR. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. OWNER, ENGINEER, ENGINEER's Consultants, other representatives and personnel of OWNER, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspecting, and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR's Site safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

A. CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. OWNER shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.B; and
3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, CONTRACTOR shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish ENGINEER the required certificates of inspection or approval.

D. CONTRACTOR shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for OWNER's and ENGINEER's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to OWNER and ENGINEER.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by CONTRACTOR without written concurrence of ENGINEER, it must, if requested by ENGINEER, be uncovered for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at CONTRACTOR's expense unless CONTRACTOR has given ENGINEER timely notice of CONTRACTOR's intention to cover the same and ENGINEER has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of ENGINEER, it must, if requested by ENGINEER, be uncovered for ENGINEER's observation and replaced at CONTRACTOR's expense.

B. If ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment. If it is found that such Work is defective, CONTRACTOR shall pay all Claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and OWNER shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, OWNER may make a Claim therefor as provided in Paragraph 10.05. If, however, such Work is not found to be defective, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times (or Milestones), or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a Claim therefor as provided in Paragraph 10.05.

13.05 *OWNER May Stop the Work*

A. If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to exercise this right for the benefit of CONTRACTOR, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

A. CONTRACTOR shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by ENGINEER, remove it from the Project and replace it with Work that is not defective. CONTRACTOR shall pay all Claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for CONTRACTOR's use by OWNER or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions: (i) repair such defective land or areas, or (ii) correct such defective Work or, if the defective Work has been rejected by OWNER, remove it from the Project and replace it with Work that is not defective, and (iii) satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the defective Work corrected or repaired or may have the rejected Work removed and replaced, and all Claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by CONTRACTOR.

B. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

C. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

D. CONTRACTOR's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, OWNER (and, prior to ENGINEER's recommendation of final payment, ENGINEER) prefers to accept it, OWNER may do so. CONTRACTOR shall pay all Claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to OWNER's evaluation of and determination to accept such defective Work (such costs to be approved by ENGINEER as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by CONTRACTOR pursuant to this sentence. If any such acceptance occurs prior to ENGINEER's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and OWNER shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, OWNER may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by CONTRACTOR to OWNER.

13.09 *OWNER May Correct Defective Work*

A. If CONTRACTOR fails within a reasonable time after written notice from ENGINEER to correct defective Work or to remove and replace rejected Work as required by ENGINEER in accordance with Paragraph 13.06.A, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, OWNER may, after seven days written notice to CONTRACTOR, correct and remedy any such deficiency.

B. In exercising the rights and remedies under this paragraph, OWNER shall proceed expeditiously. In connection with such corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the Site, take possession of all or part of the Work and suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees, OWNER's other contractors, and ENGINEER and ENGINEER's Consultants access to the Site to enable OWNER to exercise the rights and remedies under this paragraph.

C. All Claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by OWNER in exercising the rights and remedies under this Paragraph 13.09 will be charged against CONTRACTOR, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, OWNER may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of CONTRACTOR's defective Work.

D. CONTRACTOR shall not be allowed an extension of the Contract Times (or Milestones) because of any delay in the performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies under this Paragraph 13.09.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The schedule of values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to ENGINEER. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. *Applications for Payments*

1. At least 20 days before the date established for each progress payment (but not more often than once a month), CONTRACTOR shall submit to ENGINEER for review an Application for Payment filled out and signed by CONTRACTOR covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that OWNER has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect OWNER's interest therein, all of which must be satisfactory to OWNER.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of CONTRACTOR stating that all previous progress payments received on account of the Work have been applied on account to discharge CONTRACTOR's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications*

1. ENGINEER will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to OWNER or return the Application to CONTRACTOR indicating in writing ENGINEER's reasons for refusing to recommend payment. In the latter case, CONTRACTOR may make the necessary corrections and resubmit the Application.

2. ENGINEER's recommendation of any payment requested in an Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER's observations on the Site of the executed Work as an experienced and qualified design professional and on ENGINEER's

review of the Application for Payment and the accompanying data and schedules, that to the best of ENGINEER's knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.08, and to any other qualifications stated in the recommendation); and

c. the conditions precedent to CONTRACTOR's being entitled to such payment appear to have been fulfilled in so far as it is ENGINEER's responsibility to observe the Work.

3. By recommending any such payment ENGINEER will not thereby be deemed to have represented that: (i) inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to ENGINEER in the Contract Documents; or (ii) that there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER or entitle OWNER to withhold payment to CONTRACTOR.

4. Neither ENGINEER's review of CONTRACTOR's Work for the purposes of recommending payments nor ENGINEER's recommendation of any payment, including final payment, will impose responsibility on ENGINEER to supervise, direct, or control the Work or for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for CONTRACTOR's failure to comply with Laws and Regulations applicable to CONTRACTOR's performance of the Work. Additionally, said review or recommendation will not impose responsibility on ENGINEER to make any examination to ascertain how or for what purposes CONTRACTOR has used the moneys paid on account of the Contract Price, or to determine that

title to any of the Work, materials, or equipment has passed to OWNER free and clear of any Liens.

5. ENGINEER may refuse to recommend the whole or any part of any payment if, in ENGINEER's opinion, it would be incorrect to make the representations to OWNER referred to in Paragraph 14.02.B.2. ENGINEER may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in ENGINEER's opinion to protect OWNER from loss because:

a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Written Amendment or Change Orders;

c. OWNER has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

d. ENGINEER has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by OWNER to CONTRACTOR.

D. *Reduction in Payment*

1. OWNER may refuse to make payment of the full amount recommended by ENGINEER because:

a. claims have been made against OWNER on account of CONTRACTOR's performance or furnishing of the Work;

b. Liens have been filed in connection with the Work, except where CONTRACTOR has delivered a specific Bond satisfactory to OWNER to secure the satisfaction and discharge of such Liens;

c. there are other items entitling OWNER to a set-off against the amount recommended; or

d. OWNER has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If OWNER refuses to make payment of the full amount recommended by ENGINEER, OWNER must give CONTRACTOR immediate written notice (with a copy to ENGINEER) stating the reasons for such action and promptly pay CONTRACTOR any amount remaining after deduction of the amount so withheld. OWNER shall promptly pay CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by OWNER and CONTRACTOR, when CONTRACTOR corrects to OWNER's satisfaction the reasons for such action.

3. If it is subsequently determined that OWNER's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

14.03 *CONTRACTOR's Warranty of Title*

A. CONTRACTOR warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify OWNER and ENGINEER in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that ENGINEER issue a certificate of Substantial Completion. Promptly thereafter, OWNER, CONTRACTOR, and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefor. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to OWNER a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. OWNER shall have seven days after receipt of the tentative certificate during which to make written objection to

ENGINEER as to any provisions of the certificate or attached list. If, after considering such objections, ENGINEER concludes that the Work is not substantially complete, ENGINEER will within 14 days after submission of the tentative certificate to OWNER notify CONTRACTOR in writing, stating the reasons therefor. If, after consideration of OWNER's objections, ENGINEER considers the Work substantially complete, ENGINEER will within said 14 days execute and deliver to OWNER and CONTRACTOR a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as ENGINEER believes justified after consideration of any objections from OWNER. At the time of delivery of the tentative certificate of Substantial Completion ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless OWNER and CONTRACTOR agree otherwise in writing and so inform ENGINEER in writing prior to ENGINEER's issuing the definitive certificate of Substantial Completion, ENGINEER's aforesaid recommendation will be binding on OWNER and CONTRACTOR until final payment.

B. OWNER shall have the right to exclude CONTRACTOR from the Site after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Use by OWNER at OWNER's option of any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which OWNER, ENGINEER, and CONTRACTOR agree constitutes a separately functioning and usable part of the Work that can be used by OWNER for its intended purpose without significant interference with CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following conditions.

1. OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any such part of the Work which OWNER believes to be ready for its intended use and substantially complete. If CONTRACTOR agrees that such part of the Work is substantially complete, CONTRACTOR will certify to OWNER and ENGINEER that such part of the Work is

substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. CONTRACTOR at any time may notify OWNER and ENGINEER in writing that CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time after either such request, OWNER, CONTRACTOR, and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving the reasons therefor. If ENGINEER considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

2. No occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

A. Upon written notice from CONTRACTOR that the entire Work or an agreed portion thereof is complete, ENGINEER will promptly make a final inspection with OWNER and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. *Application for Payment*

1. After CONTRACTOR has, in the opinion of ENGINEER, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, Bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, CONTRACTOR may make

application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by: (i) all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Subparagraph 5.04.B.7; (ii) consent of the surety, if any, to final payment; and (iii) complete and legally effective releases or waivers (satisfactory to OWNER) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by OWNER, CONTRACTOR may furnish receipts or releases in full and an affidavit of CONTRACTOR that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which OWNER or OWNER's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, CONTRACTOR may furnish a Bond or other collateral satisfactory to OWNER to indemnify OWNER against any Lien.

B. Review of Application and Acceptance

1. If, on the basis of ENGINEER's observation of the Work during construction and final inspection, and ENGINEER's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, ENGINEER will, within ten days after receipt of the final Application for Payment, indicate in writing ENGINEER's recommendation of payment and present the Application for Payment to OWNER for payment. At the same time ENGINEER will also give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, ENGINEER will return the Application for Payment to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary

corrections and resubmit the Application for Payment.

C. Payment Becomes Due

1. Thirty days after the presentation to OWNER of the Application for Payment and accompanying documentation, the amount recommended by ENGINEER will become due and, when due, will be paid by OWNER to CONTRACTOR.

14.08 Final Completion Delayed

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

14.09 Waiver of Claims

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by OWNER against CONTRACTOR, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from CONTRACTOR's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by CONTRACTOR against OWNER other than those previously made in writing which are still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 OWNER May Suspend Work

A. At any time and without cause, OWNER may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to CONTRACTOR and ENGINEER which will fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR shall be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if CONTRACTOR makes a Claim therefor as provided in Paragraph 10.05.

15.02 OWNER May Terminate for Cause

A. The occurrence of any one or more of the following events will justify termination for cause:

1. CONTRACTOR's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);
2. CONTRACTOR's disregard of Laws or Regulations of any public body having jurisdiction;
3. CONTRACTOR's disregard of the authority of ENGINEER; or
4. CONTRACTOR's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, OWNER may, after giving CONTRACTOR (and the surety, if any) seven days written notice, terminate the services of CONTRACTOR, exclude CONTRACTOR from the Site, and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the Work all materials and equipment stored at the Site or for which OWNER has paid CONTRACTOR but which are stored elsewhere, and finish the Work as OWNER may deem expedient. In such case, CONTRACTOR shall not be

entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by OWNER arising out of or relating to completing the Work, such excess will be paid to CONTRACTOR. If such claims, costs, losses, and damages exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such claims, costs, losses, and damages incurred by OWNER will be reviewed by ENGINEER as to their reasonableness and, when so approved by ENGINEER, incorporated in a Change Order. When exercising any rights or remedies under this paragraph OWNER shall not be required to obtain the lowest price for the Work performed.

C. Where CONTRACTOR's services have been so terminated by OWNER, the termination will not affect any rights or remedies of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by OWNER will not release CONTRACTOR from liability.

15.03 OWNER May Terminate For Convenience

A. Upon seven days written notice to CONTRACTOR and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy of OWNER, elect to terminate the Contract. In such case, CONTRACTOR shall be paid (without duplication of any items):

1. for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
2. for expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;
3. for all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. for reasonable expenses directly attributable to termination.

B. CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *CONTRACTOR May Stop Work or Terminate*

A. If, through no act or fault of CONTRACTOR, the Work is suspended for more than 90 consecutive days by OWNER or under an order of court or other public authority, or ENGINEER fails to act on any Application for Payment within 30 days after it is submitted, or OWNER fails for 30 days to pay CONTRACTOR any sum finally determined to be due, then CONTRACTOR may, upon seven days written notice to OWNER and ENGINEER, and provided OWNER or ENGINEER do not remedy such suspension or failure within that time, terminate the Contract and recover from OWNER payment on the same terms as provided in Paragraph 15.03. In lieu of terminating the Contract and without prejudice to any other right or remedy, if ENGINEER has failed to act on an Application for Payment within 30 days after it is submitted, or OWNER has failed for 30 days to pay CONTRACTOR any sum finally determined to be due, CONTRACTOR may, seven days after written notice to OWNER and ENGINEER, stop the Work until payment is made of all such amounts due CONTRACTOR, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude CONTRACTOR from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to CONTRACTOR's stopping the Work as permitted by this paragraph.

ARTICLE 16 - DISPUTE RESOLUTION

16.01 *Methods and Procedures*

A. Dispute resolution methods and procedures, if any, shall be as set forth in the Supplementary Conditions. If no method and procedure has been set forth, and subject to the provisions of Paragraphs 9.09 and 10.05, OWNER and CONTRACTOR may exercise such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any dispute.

ARTICLE 17 - MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Agreement.

17.05 *Controlling Law*

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

SECTION 00800 - SUPPLEMENTARY CONDITIONS

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (EJCDC No. 1910-8, 1996 Edition) and other provisions of the Contract Documents as indicated below. All provisions, which are not so amended or supplemented, remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

SC-1.01 Defined Terms

SC-1.01 A.12. Add the following language to the first sentence of Paragraph 1.01 A.12. following the words, "the Bonds,":

"Product List Schedule."

SC-1.01 A.20. Add the following language at the end of Paragraph 1.01 A.20.:

ENGINEER's Consultants for this Project are identified as follows:

- a) ENGINEER used no consultants in the preparation of this Project.
- b) Geotechnical Consultant.
- c) Testing Agency.
- d) Environmental Consultant.

SC-1.01.A.33 Add the following new definition for Performance Specifications:

Performance Specifications—Specifications that require the manufacturer or supplier of equipment, materials, or systems to design, manufacture, deliver, and install products to achieve specific results under stipulated conditions of operation and in environments described in applicable Specification Sections. Performance Specification will be identified as such in Part 1 under System Requirements.

SC-1.01 A.43. Add the following language at the end of Paragraph 1.01 A.43.:

Substantial Completion for any portion of the Project shall include full operation of all automatic systems, including but not limited to, testing of individual system components and full operational checkout of the system.

Substantial Completion for any portion of the Project shall include opening the entire road to traffic.

Substantial Completion for any portion of the Project shall include backfilling, testing, and acceptance by OWNER of the sewer or water main system for their intended use.

SC-2.02 Copies of Documents

SC-2.02 Add the following new paragraph immediately after Paragraph 2.02 A.:

- B. Upon written request, copies of the Contract Drawings, in their entirety or by individual Drawing, may be obtained in electronic format from ENGINEER for the purchase sum of \$30 per Drawing. Upon receipt of payment, Drawings will be made available in the latest version of AutoCAD and transmitted to CONTRACTOR on a CD or DVD. E-mail transfer of Contract Drawings will not be permitted.

SC-2.03 Commencement of Contract Times; Notice to Proceed

SC-2.03 A. Amend the last sentence of Paragraph 2.03 A., by striking out the word "sixtieth" and replacing it with the word "ninetieth."

SC-2.08 Delivery of Insurance Certificates

SC-2.08 Add the following new paragraphs immediately after Paragraph 2.07 A.3.:

SC-2.08 Delivery of Insurance Certificates

- A. Provide OWNER, at the time Contracts are returned by OWNER for execution, ten (10) copies of all insurance certificates. In addition, all coverages held jointly in names of OWNER and/or ENGINEER, three (3) copies of policies shall be furnished. OWNER reserves the right to request complete copies of policies if deemed necessary to ascertain details of coverage not provided by the certificates. Such policy copies shall be "originally signed copies" and so designated.

SC-4.02 Subsurface and Physical Conditions

SC-4.02 Add the following new paragraphs immediately after Paragraph 4.02 B.:

- C. In the preparation of Drawings and Specifications, ENGINEER or ENGINEER's Consultants did not rely upon reports of explorations or tests of subsurface conditions at the Site, except as noted on Drawings.

SC-4.06 Hazardous Environmental Condition at Site

SC-4.06 Add the following new paragraphs immediately after Paragraph 4.06 I.:

- J. In the preparation of Drawings and Specifications, ENGINEER or ENGINEER's Consultants relied upon the following reports of Hazardous Environmental Conditions at the Site:
 - 1. Report dated March 15, 1990, prepared by Testing Engineers and Consultants , Troy, Michigan, entitled: Asbestos Inspection and Management Plan City of Flint Water Pollution Control Facility. The "technical data" contained in such report upon which CONTRACTOR may rely is the laboratory analysis sheets.
- K. Copies of reports itemized in SC-4.06 J. that are not included with Bidding Documents may be examined at City of Flint Water Pollution Control Facility, 4652 Beecher Road, Flint MI

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

200-156238-19001

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48532 during regular business hours. These reports are not part of the Contract Documents, but the "technical data" contained therein upon which CONTRACTOR may rely as identified and established above are incorporated therein by reference. CONTRACTOR is not entitled to rely upon other information and data utilized by ENGINEER and ENGINEER's Consultants in the preparation of Drawings and Specifications.

SC-5.02 Licensed Sureties and Insurers

SC-5.02 Add the following new paragraph immediately after Paragraph 5.02 A.:

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

SC-5.03 Certificates of Insurance

SC-5.03 Add the following new paragraph immediately after Paragraph 5.03 A.:

- B. Provide OWNER, at the time Contracts are returned by OWNER for execution, ten (10) copies of all insurance certificates. In addition, all coverages held jointly in names of OWNER and ENGINEER, three (3) copies of policies shall be furnished. OWNER reserves the rights to request complete copies of policies if deemed necessary to ascertain details of coverage not provided by the certificates. Such policy copies shall be "originally signed copies" and so designated.
- C. All insurance certificates shall include an endorsement stating the following:
 - 1. Sixty (60) days advance written notice of cancellation, non-renewal, reduction, and/or material change shall be sent, by Certified Mail, to the ENGINEER at 710 Avis Drive, Ann Arbor, Michigan 48108.

SC-5.04 CONTRACTOR's Liability Insurance

SC-5.04 Add the following new paragraphs immediately after Paragraph 5.04 B.:

- C. The limits of liability for the insurance required by Paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:
 - 1. Workers' Compensation, and related coverages under Paragraphs 5.04 A.1. and A.2. of the General Conditions:
 - a. State: Statutory
 - b. Applicable Federal

- (i.e., Longshoreman's): Statutory
- c. Employer's Liability: \$ 1,000,000
2. CONTRACTOR's General Liability under Paragraphs 5.04 A.3. through A.6. of the General Conditions which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of CONTRACTOR:
- a. General per Contract Aggregate: \$ 1,000,000
 - b. Products - Completed Operations per Contract Aggregate: \$ 1,000,000
 - c. Personal and Advertising Injury: \$ 500,000d. Each Occurrence
(Bodily Injury and Property Damage): \$500,000
 - e. Property Damage liability insurance shall provide Explosion, Collapse, and Underground coverages where applicable.
 - f. Excess or Umbrella Liability:
 - 1) General per Contract Aggregate: \$ 1,000,000
 - 2) Each Occurrence: \$ 1,000,000_
3. Automobile Liability under Paragraph 5.04 A.6. of the General Conditions:
- a. Bodily Injury:
 - Each person \$500,000
 - Each Accident \$ 500,000
 - b. Property Damage:
 - Each Accident \$ 500,000
 - c. Or a Combined Single Limit of: \$ 1,000,000
 - d. Include applicable No-Fault coverages.
 - e. Include all owned vehicles, non-owned vehicles, and hired vehicles.
4. The Contractual Liability coverage required by Paragraph 5.04 B.4. of the General Conditions shall provide coverage for not less than the following amounts:
- a. Bodily Injury:
 - Each Accident \$ 1,000,000
 - Contract Aggregate \$ 1,000,000
 - b. Property Damage:
 - Each Accident \$ 1,000,000
 - Contract Aggregate \$ 1,000,000_
5. Flood Insurance for Buildings and Contents in an amount equal to the maximum limit of coverage available under the National Flood Insurance Act of 1968.

6. The identity of the additional insureds that are to be included on CONTRACTOR's General Liability insurance policies are:
 - a. Use Owner's proper name, i.e., City of Flint, Michigan, and including all elected and appointed officials, all employees and volunteers, all boards, commissions, and/or authorities and their board members, employees, and volunteers.
 - b. Tetra Tech, Inc.
 - c. Geotechnical Consultant.
 - d. Testing Agency.
 - e. Environmental Consultant.

SC-5.05 OWNER's Liability Insurance

SC-5.05.A Delete Paragraph 5.05 A. in its entirety and insert the following in its place:

- A. CONTRACTOR shall procure and maintain during the Contract Times a separate OWNER's and CONTRACTOR's Protective (OCP) Liability Insurance in the name of OWNER in an amount not less than \$1,000,000 for injuries, including accidental death for each occurrence, and property damage in an amount not less than \$500,000 each occurrence and \$500,000 per Contract aggregate combined single limit. Tetra Tech, Inc. shall be named on the policy as an additional insured.

SC-5.06 Property Insurance

SC-5.06 A. Delete Paragraph 5.06 A. in its entirety and insert the following in its place:

- A. CONTRACTOR shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof. This insurance shall:
 1. Include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultants and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;
 2. Be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss and damage to the Work, temporary buildings, falsework, and materials and equipment in transit and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;
 3. Include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 4. Cover materials and equipment stored at the Site or at another location that was agreed to in writing by OWNER prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by ENGINEER;
 5. Allow for partial utilization of the Work by OWNER;

6. Include testing and startup; and
7. Be maintained in effect until final payment is made unless otherwise agreed to in writing by OWNER, CONTRACTOR and ENGINEER with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.
8. CONTRACTOR shall be responsible for any deductible or self-insured retention.
9. The policies of insurance required to be purchased and maintained by CONTRACTOR in accordance with this Paragraph SC-5.06 shall comply with the requirements of Paragraph 5.06 C. of the General Conditions.

SC-5.06 E. Delete Paragraph 5.06 E. in its entirety.

SC-6.03 C. Add new Paragraphs 6.03 C. and D.

- C. The Contract Documents may include Performance Specifications, which are identified as such. Where Performance Specifications are used, required systems, equipment, and/or materials to be incorporated in the Project are specified in terms of required results, without mandating specific means for achieving the required results. The functional requirements for the systems, equipment, and/or materials are defined together with the operating conditions and/or environment in which they must operate and general standards which must be satisfied. Performance Specifications establish minimum standards that must be met.
- D. Under Performance Specifications, CONTRACTOR, together with its subcontractors, suppliers, and manufacturer, are solely responsible for the design, manufacture, and performance of the specified systems, equipment, or materials. ENGINEER's review of Shop Drawings for such systems, equipment, or materials is solely to determine that appropriate operating conditions and environment have been referenced by CONTRACTOR, subcontractors, suppliers, and/or manufacturer, and is not intended for the benefit of CONTRACTOR or any other entity. Observations or requirements that ENGINEER may communicate to CONTRACTOR or others are for clarification only and shall not alter the responsibility of any party nor be interpreted to impose on OWNER or ENGINEER any liability to CONTRACTOR, subcontractors, suppliers, or manufacturers related to systems, equipment, or materials supplied pursuant to a Performance Specification. Neither CONTRACTOR nor anyone claiming rights by virtue of this Contract or any subcontract or order placed hereunder shall seek to recover from OWNER or ENGINEER any losses or damages suffered as a result of any deficiency, defect, or performance problem in any systems, equipment, or materials supplied pursuant to a performance specification.

SC-6.05 Substitutes and "Or-Equals"

SC-6.05 Add the following new paragraphs immediately after Paragraph 6.05 A.2.d.:

1. CONTRACTOR shall submit each substitute item with the Substitution Request Application in Section 01630. No substitute item will be reviewed prior to or without this application being submitted.
2. Additional information may consist of completing ENGINEER's vendor checklist, field mock-ups, special samples, pilot testing, or other special requirements that ENGINEER determines necessary to assess if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefore.

SC-6.05 Add the following new paragraphs immediately after Paragraph 6.05 E.:

1. Prior to ENGINEER's review of a substitute, ENGINEER will prepare a Work Change Directive to document ENGINEER's anticipated costs in reviewing CONTRACTOR's substitute. The Work Change Directive shall be executed prior to ENGINEER commencing its review.
2. The Work Change Directive will include ENGINEER's opinion of the probable hours required to review the substitute. ENGINEER will notify CONTRACTOR if the hours listed on the Work Change Directive are to be exceeded.
 - a. ENGINEER's minimum cost for reviewing a substitute will be \$200.
 - b. ENGINEER's hourly rate for reviewing a substitute will be \$120 per hour.

SC-6.08 Permits

SC-6.08 Add the following new paragraphs immediately after Paragraph 6.08 A.:

- B. OWNER has secured or will secure the following permits, approvals and licenses and has paid or will pay any associated charges and fees. CONTRACTOR shall pay all inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement.
 1. Michigan Department of Environmental Quality Part 41 of PA 451 Construction Permit.
- C. OWNER has submitted applications for the following permits, approvals, and licenses. CONTRACTOR is responsible for and shall pay for any associated charges and fees for the applications. CONTRACTOR shall pay all inspection fees necessary for the prosecution of the Work which are applicable at the time of Bids, or if there are no Bids, on the Effective Date of the Agreement.
 1. Soil Erosion Control Permit.
 2. Stormwater Discharge Permit.

SC-6.11 Use of Site and Other Areas

SC-6.11 Add the following language at the end of the last sentence of Paragraph 6.11 A.1.:

CONTRACTOR is responsible to ensure that all activities required to perform the Work are confined to the limits of OWNER's property and easements established for the Work. Permanent structures placed outside the limits of OWNER's property or defined permanent easements shall be relocated as necessary at no additional change in Contract Price.

SC-6.19 CONTRACTOR's General Warranty and Guarantee

SC-6.19 Add the following language at the end of the last sentence of Paragraph 6.19 A.:

The warranty and guarantee period shall be for a period of one (1) year, or such longer period of time as may be prescribed by Law, from the date of Substantial Completion.

SC-7.02 Coordination

SC-7.02 Add the following new paragraphs immediately after Paragraph 7.02 B.:

SC-7.03 Claims and Disputes Arising from Related Work at Site

- A. Should CONTRACTOR cause damage to the Work or property of any separate contractor at the Site, or should any claim arising out of CONTRACTOR's performance of the Work at the Site be made by any separate contractor against CONTRACTOR, OWNER, ENGINEER, ENGINEER's Consultants, the construction coordinator or any other person, CONTRACTOR shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration or at law.
- B. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultants, the construction coordinator and the officers, directors, partners, employees, agents and other consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including, but not limited to, fees and charges of engineers, architects, attorneys, and other professionals and court and arbitration costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any separate contractor against OWNER, ENGINEER, ENGINEER's Consultants, or the construction coordinator to the extent said claim is based on or arises out of CONTRACTOR's performance of the Work. Should a separate contractor cause damage to the Work or property of CONTRACTOR or should the performance of work by any separate contractor at the Site give rise to any other Claim, CONTRACTOR shall not institute any action, legal or equitable, against OWNER, ENGINEER, ENGINEER's Consultants, or the construction coordinator or permit any action against any of them to be maintained and continued in its name or for its benefit in any court or before any arbiter which seeks to impose liability on or to recover damages from OWNER, ENGINEER, ENGINEER's Consultants, or the construction coordinator on account of any such damage or Claim.
- C. If CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor, and OWNER and CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CONTRACTOR may make a Claim for an extension of times in accordance with Article 12. An extension of the Contract Times shall be CONTRACTOR's exclusive remedy with respect to OWNER, ENGINEER, ENGINEER's Consultants, and construction coordinator for any delay, disruption, interference, or hindrance caused by any separate contractor. This paragraph does not prevent recovery from OWNER, ENGINEER, ENGINEER's Consultant, or construction coordinator for activities that are their respective responsibilities.

SC-7.04 Assignment of Procurement Contracts from OWNER to CONTRACTOR

- A. OWNER has executed contracts for Goods and Special Services for other portions of this Project and has assigned these contracts to CONTRACTOR. CONTRACTOR's costs for assuming these contracts, unloading and handling on the Site, labor, installation costs, overhead, profit, and other expenses contemplated for the assignment of the contract have been included in the Contract Price and not in the assignment costs. No change in Contract Price on account of any of the foregoing will be valid.

- B. The following equipment will be assigned to CONTRACTOR:
 - 1. (List all OWNER PURCHASED equipment here, including reference to any contract numbers.)
- C. The following tasks shall become CONTRACTOR's responsibility upon assignment of equipment purchased by OWNER:
 - 1. Coordination of all systems interfacing with equipment.
 - 2. Scheduling and coordinating equipment delivery, loading, unloading, handling on the Site, and installation.
 - 3. Scheduling and coordination of manufacturer's services as indicated in OWNER's procurement contract.
 - 4. Equipment warranty to remain with manufacturer.
 - 5. Payments as indicated in OWNER's procurement contract.
 - 6. NOTE TO SPECIFIER: LIST ADDITIONAL RESPONSIBILITIES HERE.

SC-8.11 Evidence of Financial Arrangements

SC-8.11 Add the following new paragraph immediately after Paragraph 8.11 A.:

- B. On request of CONTRACTOR prior to the execution of any Change Order involving a significant increase in the Contract Price, OWNER shall furnish to CONTRACTOR reasonable evidence that adequate financial arrangements have been made by OWNER to enable OWNER to fulfill the increased financial obligations to be undertaken by OWNER as a result of such Change Order.

SC-9.08 Determinations for Unit Price Work

SC-9.08 A. Delete Paragraph 9.08 A. in its entirety and insert the following in its place:

- A. ENGINEER will have authority to determine the actual quantities and classifications of items of Unit Price Work performed by CONTRACTOR, and the written decisions of ENGINEER on such matters will be final, binding on OWNER and CONTRACTOR, and not subject to appeal (except as modified by ENGINEER to reflect changed factual conditions or more accurate data).

SC-11.03 Unit Price Work

SC-11.03 C. Delete Paragraph 11.03 C. in its entirety and insert the following in its place:

- C. The unit price of an item of Unit Price Work shall be subject to reevaluation and adjustment under the following conditions:
 - 1. If the total cost of a particular item of Unit Price Work amounts to ___ percent or more of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by CONTRACTOR differs by more than __ percent from the estimated quantity of such item indicated in the Agreement; and
 - 2. If there is no corresponding adjustment with respect to any other item of Work; and
 - 3. If CONTRACTOR believes that CONTRACTOR has incurred additional expense as a result thereof; or if OWNER believes that the quantity variation entitles OWNER to an adjustment

in the unit price, either OWNER or CONTRACTOR may make a claim for an adjustment in the Contract Price in accordance with Article 10 if the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

SC-12.01 Change of Contract Price

SC-12.01 Add the following new paragraphs immediately after Paragraph 12.01 C.2.f.:

g. An example of how the procedure works is:

Cost of Work Performed or Furnished by Sub-Subcontractor	\$10,000.00
Sub-Subcontractor's Fee (15%)	<u>\$1,500.00</u>
Total Paid by Subcontractor to Sub-Subcontractor	\$11,500.00
Subcontractor's Fee (5%)	<u>\$575.00</u>
Total Paid by Contractor to Subcontractor	\$12,075.00
Contractor's Fee (5%)	<u>\$603.75</u>
Total Cost of Work plus Fee	\$12,678.75

SC-12.02 Change of Contract Times

SC-12.02 Add the following new paragraphs immediately after Paragraph 12.02 B.:

- C. The termination of Work during the winter season on account of cold weather shall not be taken as entitling CONTRACTOR to any extension of Contract Time.
- D. CONTRACTOR shall maintain all construction signage and traffic control devices during the termination of Work during the winter season.

SC-14.02 Progress Payments

SC-14.02.C.1 Delete Paragraph 14.02.C.1. in its entirety and insert the following in its place:

- 1. Thirty days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02 D.) become due, and when due will be paid by OWNER to CONTRACTOR; except when funds with which payments are made are provided by a department or agency of the State or Federal government, in which case payment to CONTRACTOR shall be made within fifteen (15) days after OWNER receives said funds.

SC-14.04 Substantial Completion

SC-14.05 Partial Utilization

SC-14.05 A.2. Amend Paragraph 14.05 A.2. to read as 14.05 A.3.

SC-14.05 A. Add the following new paragraph immediately after Paragraph 14.05 A.1.:

2. OWNER may at any time request CONTRACTOR in writing to permit OWNER to take over operation of any part of the Work although it is not substantially complete. A copy of such request will be sent to ENGINEER, and within a reasonable time thereafter OWNER, CONTRACTOR, and ENGINEER shall make an inspection of that part of the Work to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If CONTRACTOR does not object in writing to OWNER and ENGINEER that such part of the Work is not ready for separate operation by OWNER, ENGINEER will finalize the list of items to be completed or corrected and will deliver such lists to OWNER and CONTRACTOR together with a written recommendation as to the division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, utilities, insurance, warranties, and guarantees for that part of the Work which will become binding upon OWNER and CONTRACTOR at the time when OWNER takes over such operation (unless they shall have otherwise agreed in writing and so informed ENGINEER). During such operation and prior to Substantial Completion of such part of the Work, OWNER shall allow CONTRACTOR reasonable access to complete or correct items on said list and to complete other related Work.

SC-16.01 Methods and Procedures

SC-16.01 A. Delete Paragraph 16.01 A. in its entirety and insert the following in its place:

- A. Appeals of decisions rendered by ENGINEER pursuant to Paragraphs 9.09 and 9.10 of the General Conditions shall be resolved by formal proceedings instituted by the appealing party in a forum of competent jurisdiction instituted within sixty (60) days of the date of such decision, unless otherwise agreed in writing by OWNER and CONTRACTOR.

SC-16.01 Add the following new paragraphs immediately after Paragraph 16.01 A.:

SC-16.02 Mediation

- A. OWNER and CONTRACTOR agree that they shall submit any and all unsettled Claims or counterclaims, disputes, or other matters in question between them arising out of or relating to the Contract Documents or the breach thereof to mediation by the rules of the American Arbitration Association [prior to either of them initiating against the other a demand for arbitration pursuant to Paragraph SC-16.03, unless delay in initiating arbitration would irrevocably prejudice one of the parties. The 30-day time limit within which to file a demand for arbitration as provided in Paragraphs SC-16.03.B and 16.03.C shall be suspended with respect to a dispute submitted to mediation within that time limit and shall remain suspended until 10 days after the termination of the mediation.] The mediator of any dispute submitted to mediation under this agreement shall not serve as arbitrator of such dispute unless otherwise agreed.

SC-16.03 Arbitration

- A. All 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 14.09) not resolved under the provisions of Paragraph SC-16.02 will

be decided by binding arbitration in accordance with the rules of the American Arbitration Association then obtaining, subject to the limitations of this Paragraph SC-16.03. 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. No demand for arbitration of any Claim or counterclaim, dispute, or other matter that is required to be referred to ENGINEER initially for decision in accordance with Paragraph 9.09 will be made until the earlier of: (i) the date on which ENGINEER has rendered a written decision, or (ii) the 31st day after the parties have presented their final evidence to ENGINEER if a written decision has not been rendered by ENGINEER before that date. No demand for arbitration of any such Claim or counterclaim, dispute, or other matter will be made later than 30 days after the date on which ENGINEER has rendered a written decision in respect thereof in accordance with Paragraph 10.05; and the failure to demand arbitration within said 30-day period will result in ENGINEER's decision being final and binding upon OWNER and CONTRACTOR. If ENGINEER renders a decision after arbitration proceedings have been initiated, such decision may be entered as evidence but will not supersede the arbitration proceedings, except where the decision is acceptable to the parties concerned.
- C. Notice of the demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitrator, 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 SC-16.03 B., 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 statute of limitations.
- D. Except as provided in Paragraph SC-16.03 E., 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; and
 - 3. The written consent of the other individual or entity sought to be included and of OWNER and CONTRACTOR has been obtained for such inclusion, which consent shall make specific reference to this paragraph; but no such consent shall constitute consent to arbitration of any dispute not specifically described in such consent or to arbitration with any party not specifically identified in such consent.
- E. Notwithstanding Paragraph SC-16.03 D., if a Claim or counterclaim, dispute, or other matter in question between OWNER and CONTRACTOR involves the Work of a Subcontractor, either OWNER or CONTRACTOR may join such Subcontractor as a party to the arbitration between OWNER and CONTRACTOR hereunder. CONTRACTOR shall include in all

subcontracts required by Paragraph 6.06.G a specific provision whereby the Subcontractor consents to being joined in an arbitration between OWNER and CONTRACTOR involving the Work of such Subcontractor. Nothing in this Paragraph SC-16.03 E., or in the provisions of such subcontract consenting to joinder shall create any claim, right, or cause of action in favor of Subcontractor and against OWNER, ENGINEER, or ENGINEER's Consultants that does not otherwise exist.

- F. The award rendered by the arbitrators 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.

SC-17 Miscellaneous

SC-17.05 Add the following new paragraphs immediately after Paragraph 17.5 A.:

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

SC-17.06 Funding Agency Requirements

- A. OWNER will require the use of prevailing wage rates on this Project. CONTRACTOR must comply with:
 - 1. Section 00450 - Prevailing Wage Rates, General Decision Number MI20200083, dated 05/08/2020.
- B. OWNER will utilize funds from the Environmental Protection Agency (EPA) on the Project. CONTRACTORS must comply with:
 - 1. 41 CFR Part 60-4, Construction Contractors Affirmative Action requirements.
 - 2. 40 CFR Part 31, Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments.

END OF SECTION

SECTION 01110 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. The Project is located at City of Flint Water Pollution Control Facility, 4652 Beecher Road, Flint MI 48532.
- B. The Work consists improvements to the aeration system at the City of Flint Water Pollution Control Facility. The works includes installation of three new aeration blowers. Also includes installation of a low energy mixing system in secondary treatment influent and effluent channels, portions of the Battery B Aeration tanks and primary tank influent channels. The works also includes installation of fine bubble diffuser equipment in one tank of the Battery B aeration system, replacement of valves, piping and instrumentation within the Aeration Tank Galleries, replacement and removal of a number of existing channel gates, concrete repairs to the existing structures, and electrical and instrumentation improvements.

1.02 GENERAL CONSTRAINTS AND WORK SEQUENCE

- A. CONTRACTOR shall arrange its Work so that at no time shall it cause unnecessary interruption to the operation of existing facilities. When construction operations must be done with any portion of the existing facilities out of service, such Work shall be done at such times and in the sequence as recommended by ENGINEER and with the prior approval of the Michigan Department of Environmental Quality, if required. During such period of curtailment of facility operation, the Work shall be done with all haste possible under the circumstances, even to the extent of working continuously 24 hours a day for this period. General constraints and temporary treatment process facility requirements that the CONTRACTOR shall incorporate in the Project schedule and sequence of construction are outlined below. Note that this listing is not represented as comprehensive or complete. Additional accommodations to facilitate operation and other temporary facilities shall also be required to complete the work
- B. Suggested Sequence of Construction
 1. Work shall begin in Battery A portion of the facility inconjunction with the Grit Removal Improvments Project.
 2. The existing stop plate in the channel between the Battery A and B Primary effluent channels shall be put in place to isolate Battery A. At that point the Battery A influent gate shall be installed or a temporary bulkhead so that flow from Battery A primary can then be routed to Battery B aeration.
 3. Work shall proceed in the Battery A including modification in galleries, aeration tanks, influent and effluent channels
 4. A bulkhead plate shall be installed across the opening of the existing 48x48 Battery A and B effluent channel gate to facilitate the replacement of the gate with the Battery B portion of the work. Bulkhead to be removed after Battery B work completed and returned to service.
 5. Work in Battery A primary influent channel shall also be completed in conjunction with Grit Removal Improvments project.
 6. After work in Battery A is completed and in coordination with the Grit Removal Improvments project, flow shall be reintroduced to Battery A and the system shall be operated for 14 days without error. At the completion of this test time Battery B can be taken off line.

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

200-156238-19001

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7. The existing stop plate in the channel between the Battery A and B Primary effluent channels shall be put in place to isolate Battery B.
 8. The work in Battery B shall then be completed including modifications in galleries, aeration tanks, influent and effluent channels.
 9. The replacement of the existing Battery B 84" diameter Primary Effluent sluice gate shall be completed when Battery B primary is taken offline, this work shall be completed in 7 days.
 10. The installation of new Aeration Blowers can take place at any time as long as the blowers in the Equipment Building are operational.
 11. A temporary plug balloon shall be installed in existing Main Air Header to isolate Battery A and Battery B header as necessary to perform the work.
 12. The installation of new large bubble mixing compressor system and piping in galleries can take place at any time.
- C. If CONTRACTOR wishes to propose an alternate sequence of construction for maintaining operation of existing facilities, CONTRACTOR shall submit complete details of its plan to ENGINEER for approval.
- D. General Constraints
1. Influent flow and water service to the WPC shall be maintained at all times.
 2. No interruptions of any part of the WPC treatment process shall occur without the expressed prior approval of the OWNER and ENGINEER. Requests shall allow no less than 72 hours for plant staff to make necessary arrangements to properly accommodate any required shutdowns. Longer period of time to facilitate changes in operation may be required at the sole discretion of the OWNER.
 3. The CONTRACTOR shall be completely responsible for fines or other enforcement imposed upon the OWNER facility resulting from inadvertent or unplanned treatment interruptions caused by the CONTRACTOR that result in NPDES permit violations.
 4. CONTRACTOR shall provide Drawings and other necessary details of temporary facilities for approval prior to purchase, installation or interruption of any plant process.
 5. CONTRACTOR shall place matting over all tunnels, channels, tanks, and piping where heavy equipment will be travelling. CONTRACTOR shall also install shoring in tunnels and channels where heavy equipment will travel over. Extent of areas may not be shown on the drawings. Verify with Owner and Engineer before any large equipment is brought on site.
 6. The WPC shall attempt to flush sediment from channels, tanks and pipes to the best of their ability. CONTRACTOR shall be prepared to handle and remaining solids or liquid as necessary to perform their works. Remaining solids levels may but 3-4 inches.

1.03 CONTRACTOR USE OF PREMISES

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

- C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.
- D. CONTRACTOR may use existing overhead cranes in building if the following items are met;
 - 1. CONTRACTOR must submit in writing a request to OWNER to use building crane hoists
 - 2. OWNER will instruct CONTRACTOR in proper operation of the equipment
 - 3. CONTRACTOR must maintain a sign in sheet for operation of equipment

1.04 OWNER OCCUPANCY

- A. Full OWNER Occupancy: OWNER will occupy the Site and existing building during the entire construction period. Cooperate with OWNER during construction operations to minimize conflicts and facilitate OWNER usage. Perform the Work so as not to interfere with OWNER's operations.

1.05 MISCELLANEOUS PROVISIONS

- A. Time and Sequence of Work: In general, it is the intention and understanding that CONTRACTOR shall have control over the sequence or order of execution of the several parts of the Work to be done under the Contract and over the method of accomplishing the required results, except as some particular sequence or method may be distinctly demanded by the Drawings and Project Manual or by the expressed provisions of the Contract. ENGINEER may, however, make such reasonable requirements as may, in ENGINEER's judgment, be necessary for the proper and effective protection of Work partially or wholly completed, and to these requirements CONTRACTOR shall conform.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01210 - ALLOWANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for processing Allowances. Selected materials and equipment, and in some cases their installation, are shown and specified in the Contract Documents by Allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. Additional requirements, if necessary, will be issued by Change Order.

1.02 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. Unit-cost Allowance: A specified quantity of a product or assembly, as part of the Contract Price, that is to be included in the Work even though the location of the product or assembly is not indicated on Drawings or shown in the specifications.
- C. Contingency Allowance: A monetary sum that, as part of the Contract Price, is to be utilized as directed by OWNER, through a Change Order, to cover minor changes in the Work.
- D. Provisionary Allowance: A monetary sum that, as part of the Contract Price, is to be utilized as directed by OWNER, through a Change Order, to cover minor changes in the Work.

1.03 SUBMITTALS

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

1.04 OWNER'S INSTRUCTIONS

- A. At the earliest feasible date after Contract Award, 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, obtain Bids for each Allowance for use in making final selections; include recommendations that are relevant to performance of the Work.
- C. Purchase products and systems as selected by ENGINEER from the designated supplier.
- D. Use Allowances 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 Paragraph 11.02 of the General Conditions.
- F. Change Orders authorizing use of funds from the Contingency or Provisionary Allowances will include CONTRACTOR's related costs and reasonable overhead and profit margins.
- G. At Project closeout, any amounts remaining in Allowances will be credited to OWNER by Change Order.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect products covered by an Allowance promptly upon delivery for damage or defects.

3.02 PREPARATION

- A. Coordinate materials and their installation for each Allowance with related materials and installations to ensure that each Allowance item is completely integrated and interfaced with related construction activities.

SCHEDULE OF ALLOWANCES

1. Lump Sum Allowance for WPC Aeration System Impementation. Allowance shall include all instrumentation and communication programming between manufacturer supplied control systems and the WPC SCADA system. An Allowance of \$150,000 shall be included in the Bid Price for these services. The work shall be performed by Tetra Tech. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract.
2. Allowance for Unforeseen Site Conditions. An allowance in the amount of \$125,000 shall be included in the Contract Price for Work related to unforeseen conditions including but not limited to relocation of existing utilities, concrete restoration, replacement of components found to be inoperable and changed existing conditions. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract.

END OF SECTION

SECTION 01230 - ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

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

1.03 OWNER'S INSTRUCTIONS

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

SCHEDULE OF ALTERNATES

Alternates to the Base Bid Form are offered as follows:

Alternate No. 1

Description: The Alternate consists of the deletion of the work to be performed to Battery B Aeration Tank 1, Passes 1 through 4. This include installation of fine pore diffusers, compressed air mixing system, valve replace, piping modifications, and associated electrical and instrumentation associated the with the Tank 1 modifications.

Reference Drawing No. D-003, 004, 005, 105, 107, 108, 303, 305 and associated E and I sheets.

Alternate No. 2

Description: The Alternate consists of the deletion of the work related into the installation of the compressed air mixing system within the 4th pass of each Battery B aeration tank, Tanks 1 – 5. This include mixing grids, air piping, and related electrical and controls components. The specified compressor units in the Equipment Building and work in the channels shall remain

Reference Drawing No. D-003, 004, 005, 105, 107, 108, 303, 305 and associated E and I sheets.

END OF SECTION

SECTION 01290 - APPLICATIONS FOR PAYMENT

PART 1 – GENERAL

1.01 SUMMARY

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

1.02 OWNER'S INSTRUCTIONS

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

10. Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually on Applications for Payment. Each item on Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.
 11. At CONTRACTOR's option, temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown as separate line items on Schedule of Values or distributed as general overhead expense.
 12. Update and resubmit Schedule of Values when Change Orders or Work Change Directives result in a change in the Contract Price.
- B. Initial Application for Payment: Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
1. List of subcontractors.
 2. List of principal suppliers and fabricators.
 3. Schedule of Values.
 4. CONTRACTOR's Construction Schedule (preliminary if not final).
 5. Schedule of principal products.
 6. Schedule of unit prices.
 7. Submittal Schedule (preliminary if not final).
- C. Applications For Payment:
1. Work, installation, equipment, etc. will not be paid past 90% complete until work, installation, equipment has been started, fully functional, and passed all performance tests to the satisfaction of the Engineer. This includes payment for stored equipment.
 2. The OWNER shall pay up to 70 percent on equipment and material that has been delivered to the site but is not yet installed. Items shall be properly stored and maintained per manufacturer guidelines.
 3. Each Application for Payment shall be consistent with previous applications and payments as certified by ENGINEER and paid for by OWNER.
 4. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
 5. The date for each progress payment will be determined at the Pre-Construction Conference. The period of construction Work covered by each Application for Payment is 1 month. Actual start/end dates will be determined at the Pre-Construction Conference.
 6. Use the pay application form included in Section 00620 for Applications for Payment.
 7. Complete every entry on the form, including execution by person authorized to sign legal documents on behalf of CONTRACTOR. Incomplete applications will be returned without action.
 8. Entries shall match data on Schedule of Values and CONTRACTOR's Construction Schedule. Use updated Schedules if revisions have been made.
 9. Include amounts of Change Orders and Work Change Directives issued prior to the last day of the construction period covered by the application.
 10. Submit 3 executed copies of each Application for Payment to ENGINEER; 1 copy shall be complete, including waivers of lien and similar attachments, when required.
 11. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to ENGINEER.

- D. Application for Payment at Substantial Completion:
1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for OWNER occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall proceed or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Meter readings.
 - f. Start-up performance reports.
 - g. Changeover information related to OWNER's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. Advice on shifting insurance coverages.
 - k. Final progress photographs.
 - l. List of incomplete Work, recognized as exceptions to ENGINEER'S Certificate of Substantial Completion.
- E. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
1. Completion of Project closeout requirements.
 2. Completion of items specified for completion after Substantial Completion.
 3. Assurance that unsettled claims will be settled.
 4. Assurance that Work not complete and accepted will be completed without undue delay.
 5. Transmittal of required Project construction records to OWNER.
 6. Proof that taxes, fees, and similar obligations have been paid.
 7. Removal of temporary facilities and services.
 8. Removal of surplus materials, rubbish, and similar elements.
 9. Change of door locks to OWNER's access.
 10. CONTRACTOR's waivers of mechanics liens for Project.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01310 - PROJECT COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:
 - 1. Coordination of Work under this Contract.
 - 2. Coordination with other Contractors.
 - 3. Administrative and supervisory personnel.
 - 4. Land survey work.
 - 5. Pre-Construction Conference.
 - 6. Pre-Excavation Conference.
 - 7. Pre-Installation Conference.
 - 8. Progress meetings.
 - 9. General installation provisions.
 - 10. Cleaning and protection.
- B. Related Sections Specified Elsewhere:
 - 1. Equipment installation check, and operation, maintenance, and training of OWNER's personnel are included in Section 01600 and Sections for specific equipment items.
 - 2. Requirements for CONTRACTOR's Construction Schedule are included in Section 01330.

1.02 SUBMITTALS

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

1.03 SCHEDULING

- A. Coordinate construction operations included under different Sections of the Specifications that are dependent upon each other for proper installation, connection, and operation. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair. Make adequate provisions to accommodate items scheduled for later installation.
- B. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at Site in accordance with Laws or Regulations. CONTRACTOR shall train CONTRACTOR's employees on use of these sheets and shall keep a master copy on hand at Site.
- C. Coordination with Other Contractors:
 - 1. CONTRACTOR shall so conduct CONTRACTOR's operations as not to interfere with or injure the Work of other Contractors or workmen employed on adjoining or related Work, and

CONTRACTOR shall promptly make good any injury or damage which may be done to such Work by CONTRACTOR or CONTRACTOR's employees or agents.

2. Should a contract for adjoining Work be awarded to another CONTRACTOR, and should the Work on one of these contracts interfere with that of the other, ENGINEER shall decide which contract shall cease Work for the time being and which shall continue, or whether Work on both contracts shall continue at the same time and in what manner.

- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Project closeout activities.

1.04 PRE-CONSTRUCTION CONFERENCE

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

1.05 PRE-INSTALLATION CONFERENCE

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

1.06 PROGRESS MEETINGS

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 LAND SURVEY WORK

- A. CONTRACTOR Performance:
 - 1. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks before proceeding to layout the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
 - a. Record benchmark locations, with horizontal and vertical data, on Contract Record Documents.
 - 2. Working from lines and levels established by ENGINEER, establish benchmarks and markers to set lines and levels at each area of Work and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Do not scale Drawings to determine dimensions.

3. Benchmarks or control points shall not be changed or relocated without prior written approval by ENGINEER. Promptly report lost or destroyed reference points, or requirements to relocate reference points because of necessary changes in grades or locations.
4. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points.
5. Advise entities engaged in construction activities, of marked lines and levels provided for their use.
6. As construction proceeds, check every major element for line, level and plumb.
7. Site Improvements: Locate and lay out site improvements, including pavements, stakes for grading, fill and topsoil placement, utility slopes, and invert elevations by instrumentation and similar appropriate means.
8. Building Lines and Levels: Locate and lay out batter boards for structures, building foundations, column grids and locations, floor levels, and control lines and levels required for mechanical and electrical Work.
9. Existing Utilities and Equipment:
 - a. The existence and location of underground and other utilities and construction as shown on Drawings as existing are not guaranteed. Before beginning Site Work, CONTRACTOR shall investigate and verify the existence and location of underground utilities and other construction.
 - b. Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction. Coordinate with local authorities having jurisdiction.
 - c. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping.

3.02 CLEANING AND PROTECTION

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

END OF SECTION

SECTION 01330 - SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals, including, but not necessarily limited to, the following:
 - 1. CONTRACTOR's Construction Schedule.
 - 2. Submittal Schedule.
 - 3. Shop Drawings.
 - 4. Product data.
 - 5. Samples.
 - 6. Progress photographs.
 - 7. Record photographs.
- B. Topics covered elsewhere include, but are not limited to:
 - 1. Permits.
 - 2. Applications for payment.
 - 3. Performance and payment bonds.
 - 4. Insurance certificates.
 - 5. List of subcontractors.

1.02 SUBMITTALS

- A. Bonds and Insurance Certificates shall be submitted to and approved by OWNER and ENGINEER prior to the initiation of any construction on Site.
- B. Permits, Licenses, and Certificates: For OWNER's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents; correspondence and records established in conjunction with compliance with standards; and regulations bearing upon performance of the Work.

1.03 SUBMITTAL PROCEDURES

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

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

C. Submittal Preparation:

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

D. Submittal Transmittal:

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

1.04 CONSTRUCTION SCHEDULE

A. Bar Chart Schedule:

1. Prepare a fully developed, horizontal bar chart type Construction Schedule. Submit within 30 days of the date established for "NOTICE TO PROCEED."
2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated on Schedule of Values.
3. Prepare Schedule on a sheet, or series of sheets, of stable transparency or other reproducible media, of sufficient width to show data for the entire construction period.
4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on Schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
5. Coordinate Construction Schedule with Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on Schedule to allow time for ENGINEER's procedures necessary for certification of Substantial Completion.

B. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

1.05 SUBMITTAL SCHEDULE

- A. After development and acceptance of Construction Schedule, prepare a complete Schedule of Submittals. Submit Schedule within 10 days of the date required for establishment of Construction Schedule.
- B. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products, as well as Construction Schedule.
- C. Prepare Schedule in chronological order; include submittals required during the first 90 days of construction. Provide the following information:
 1. Scheduled date for the first submittal.
 2. Related Section number.
 3. Submittal category.
 4. Name of subcontractor.
 5. Description of the part of the Work covered.
 6. Scheduled date for resubmittal.
 7. Scheduled date ENGINEER's final release or approval.
- D. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.
- E. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

- F. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

1.06 SHOP DRAWINGS

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

1.07 PRODUCT DATA

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

- B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
 - 1. Manufacturer's printed recommendations.
 - 2. Compliance with recognized trade association standards.
 - 3. Compliance with recognized testing agency standards.
 - 4. Application of testing agency labels and seals.
 - 5. Notation of dimensions verified by field measurement.
 - 6. Notation of coordination requirements.
- C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

1.08 SAMPLES

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

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

1.09 ENGINEER'S ACTION

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

1.10 PROGRESS PHOTOGRAPHS

- A. During the process of the Work, photographs shall be taken at the rate of at least 4 every month from start of construction until acceptance by OWNER. These photographs shall be taken from points and at the times directed by ENGINEER.
- B. Digital files in high resolution JPEG format and of adequate quality to reproduce prints of approximately 7-1/2 x 9-1/2 inches overall, shall be provided to ENGINEER and OWNER. However, the requirement for numbers of prints and binding shall remain unchanged. At the conclusion of the Work, the digital files shall become the property of the OWNER.
 - 1. Upon completion of the Work, the digital photos shall be copied to two CD's and shall be turned over to the OWNER.

1.11 RECORD PHOTOGRAPHS

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01420 - DEFINITIONS AND STANDARDS

PART 1 - GENERAL

1.01 DEFINITIONS

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

1.02 INDUSTRY STANDARDS

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

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

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

ACPA	American Concrete Pipe Association 222 West Las Colinas Blvd., Suite 641; Irving, TX 75039-5423
AGA	American Gas Association 400 N Capitol St., NW; Washington, D.C. 20001
AGMA	American Gear Manufacturers Association
AI	Asphalt Institute Research Park Dr., P.O. Box 14052; Lexington, KY 40512-4052
A.I.A.	American Insurance Association 1130 Connecticut Ave., NW, Suite 1000; Washington, D.C. 20036
AISC	American Institute of Steel Construction One East Wacker Dr., Suite 3100; Chicago, IL 60601-2001
AISI	American Iron and Steel Institute 1101 Seventeenth St., NW; Washington, D.C. 20036
ALI	Associated Laboratories, Inc. P.O. Box 152837; Dallas, TX 75315
ANSI	American National Standards Institute 25 West 43 rd St.; New York, NY 10036
ASCE	American Society of Civil Engineers 1801 Alexander Bell Dr.; Reston, VA 20191-4400
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, NE; Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th St.; New York, NY 10017
ASSE	American Society of Safety Engineers 1800 East Oakton Street, Des Plaines, IL 60018
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr.; West Conshohocken, PA 19428-2959
AWS	American Welding Society 550 NW Le Jeune Rd.; Miami, FL 33126
AWWA	American Water Works Association 6666 W. Quincy Ave.; Denver, CO 80235

CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Rd.; Schaumburg, IL 60173
CSA	Canadian Standards Association
FM	Factory Mutual Engineering and Research 1151 Boston-Providence Turnpike; Norwood, MA 02062-9102
H.I.	Hydraulic Institute 9 Sylvan Way; Parsippany, NJ 07054
IEEE	Institute of Electrical and Electronic Engineers 3 Park Ave., 17 th Floor; New York, NY 10016-5997
ISA	Instrument Society of America 67 Alexander Dr.; Research Triangle Park, NC 27709
MBMA	Metal Building Manufacturers Association 1300 Summer Ave.; Cleveland, OH 44115-2851
NAPA	National Asphalt Pavement Association 5100 Forbes Blvd.; Lanham, MD 20706-4413
NCPI	National Clay Pipe Institute P.O. Box 759; Lake Geneva, WI 53147
NEC	National Electrical Code (by NFPA)
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association 1300 North 17 th St., Suite 1847; Rosslyn, VA 22209
NFPA	National Fire Protection Association 1 Batterymarch Park; Quincy, MA 02269-9101
NPCA	National Precast Concrete Association 10333 North Meridian St., Suite 272; Indianapolis, IN 46290
PCA	Portland Cement Association 5420 Old Orchard Rd.; Skokie, IL 60077-1083
PCI	Precast/Prestressed Concrete Institute 209 W. Jackson Blvd.; Chicago, IL 60606-6938
PDI	Plumbing and Drainage Institute 800 Turnpike Street, Suite 300, North Andover, MA 01845
PTI	Post-Tensioning Institute 1717 W. Northern Ave., Suite 114; Phoenix, AZ 85021

SDI	Steel Deck Institute P.O. Box 25; Fox River Grove, IL 60021-0025
SJI	Steel Joist Institute 3127 10 th Ave. North Ext.; Myrtle Beach, SC 29577-6760
SMACNA	Sheet Metal & Air Conditioning Contractors' National Association 4201 Lafayette Center Dr.; Chantilly, VA 20151-1209
SSPC	The Society for Protective Coatings 40 24 th St., 6 th Floor; Pittsburgh, PA 15222-4565
TPI	Truss Plate Institute 583 Donofrio Dr., Suite 200; Madison, WI 53719
UL	Underwriters Laboratories 333 Pfingsten Rd.; Northbrook, IL 60062-2096

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

CE	Corps of Engineers (U.S. Department of the Army) Chief of Engineers - Referral Washington, D.C. 20314
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol Street between G and H St. NW Washington, D.C. 20402 (Material is usually first published in the Federal Register)
DOT	Department of Transportation 400 Seventh Street, SW Washington, D.C. 20590
EDA	Economic Development Administration U.S. Department of Commerce 121 N. Canal Street, Suite 855 Chicago, IL 60606
EGLE	Michigan Department of Environment, Great Lakes, and Energy

EPA	Environmental Protection Agency 401 M Street, SW Washington, D.C. 20460
MDOT	Michigan Department of Transportation
MIOSHA	State of Michigan OSHA
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) Government Printing Office Washington, D.C. 20402

1.03 GOVERNING REGULATIONS/AUTHORITIES

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

1.04 SUBMITTALS

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01450 - QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 CONTRACTOR RESPONSIBILITIES

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

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

1.03 OWNER RESPONSIBILITIES

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

1.04 TESTING AGENCY RESPONSIBILITIES

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

1.05 SUBMITTALS

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

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

END OF SECTION

SECTION 01500 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: This Section specifies procedural and administrative requirements for temporary services and facilities.
- B. Temporary Utilities include, but are not limited to:
 - 1. Water service and distribution.
 - 2. Temporary electric power.
 - 3. Temporary lighting.
 - 4. Storm and sanitary sewer.
- C. Temporary Construction and Support Facilities include, but are not limited to:
 - 1. Temporary heating facilities.
 - 2. CONTRACTOR's field offices and storage sheds.
 - 3. ENGINEER's field office.
 - 4. Temporary roads and paving.
 - 5. Sanitary facilities.
 - 6. Dewatering facilities and drains.
- D. Construction Buildings and Facilities include, but are not limited to.
 - 1. Temporary enclosures.
 - 2. Temporary Project identification signs.
 - 3. Temporary Site identification signs.
 - 4. Temporary Project bulletin boards.
 - 5. Stairs.
 - 6. Hoists.
 - 7. Ongoing construction cleanup.
 - 8. Rodent and pest control.
 - 9. Storage of equipment and material.
- E. Security and Protection Facilities required include, but are not limited to:
 - 1. Temporary fire protection.
 - 2. Barricades, warning signs, lights.
 - 3. Enclosure fence for the Site.
 - 4. Security enclosure and lockup.
 - 5. Environmental protection.
 - 6. Control of noise.
 - 7. Dust control.
- F. Sedimentation Control Facilities required include, but are not limited to:
 - 1. Soil erosion and sedimentation control.
 - 2. Stormwater discharge control.
 - 3. Dewatering trenches and disposal of excess excavated material.
 - 4. Slope protection.
 - 5. Final topography protection.

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1.02 REFERENCES

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

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to:
 - 1. Building Code requirements.
 - 2. Health and Safety regulations.
 - 3. Utility Company regulations.
 - 4. Police, Fire Department, and Rescue Squad rules.
 - 5. Environmental Protection regulations.
 - 6. State and Local Soil Erosion and Sedimentation Control regulations.
- B. Inspection: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.05 PROJECT CONDITIONS

- A. Unless otherwise provided in these Specifications, CONTRACTOR shall make CONTRACTOR's own arrangements for electricity, gas, water, and sewer services for use during the construction of the Work and shall pay for all temporary facilities, connections, extensions, and services.
 - 1. Cost or use charges for temporary facilities are not chargeable to OWNER or ENGINEER, and will not be accepted as a basis of claims for a Change Order.
- B. Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do no overload facilities or permit them to interfere with progress. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on Site.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide new materials; if acceptable to ENGINEER, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Water: Provide potable water approved by local health authorities.
- C. Open-Mesh Fencing: Provide 11-gauge, galvanized 2-inch, chain-link fabric fencing 6 feet high with galvanized barbed wire top strand and galvanized steel pipe posts, 1-1/2-inch inside diameter for line posts and 2-1/2-inch inside diameter for corner posts.
- D. Seed: Consisting of, per acre, 10 pounds Kentucky 31 fescue, 3 pounds Birdsfoot Trefoil, and 3 pounds white clover.
- E. Fertilizers: Consisting of, at least, 200 pounds per acre 12:12:12, or equivalent.
- F. Mulches: Consisting of 2 tons per acre of straw or hay. Chemical mulch or other approved material may be used.
- G. Traffic Control Devices:
 - 1. Barricades: When a road or street is closed to all through traffic, movable Type III barricades shall be erected at all points of closures, including cross streets. If barricades are to be left over night, 3 warning lights shall be provided for each Type III barricade.
 - 2. Barriers: Whenever the excavation on roads open to through traffic exceeds 10 feet below surface grade, portable concrete barriers shall be provided between the open trench and any traffic lanes including barriers at the ends of the trench as necessary. The maximum length of open trench shall be 50 feet.
 - 3. Lane Control: Provide by using drums to channel the traffic flow, supplemented by guide signs and/or flagpersons as necessary. Lighted arrow panels, Type A, shall be required for lane control on both State trunk lines and all city streets open to through traffic.
 - 4. Signs: Standard sign sizes and colors, as shown in "MMUTCD," shall be used to make the approach to construction areas and to direct motorists on any detour route. All signs shall be reflectorized.

5. Temporary Pavement Marking: Complying with Section 811 of Michigan Department of Transportation's 2003 Standard Specifications for Construction.

2.02 EQUIPMENT

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

PART 3 - EXECUTION

3.01 INSTALLATION

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

3.02 TEMPORARY UTILITY INSTALLATION

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

power will not be paid for by OWNER until construction is 90 percent complete as determined by the payment certificates. Any costs associated with CONTRACTOR requests for power prior to the 90 percent construction completion will be paid for by CONTRACTOR. In no case shall OWNER begin paying the entire electrical bill until OWNER has beneficial use of the facilities.

- E. Public and Private Utilities: Where any utilities, water, sewer, gas, telephone, or any other either public or private, are encountered, CONTRACTOR must provide adequate protection for them, and CONTRACTOR shall be held responsible for any damages to such utilities arising from CONTRACTOR's operations.
1. When it is apparent that construction operations may endanger the foundation of any utility conduit or the support of any structure, CONTRACTOR shall notify the utility Owner of this possibility and CONTRACTOR shall take such steps as may be required to provide temporary bracing or support of conduits or structures.
 2. Where it is the policy of utility Owners to make repairs to damaged conduit or other structures, CONTRACTOR shall cooperate to the fullest extent with the utility, and CONTRACTOR shall see that CONTRACTOR's operations interfere as little as possible with those operations.
 3. When it is necessary to carry out the Work, that an electric, telephone, or light pole be moved to a new location, or moved and replaced after construction, CONTRACTOR shall arrange for the moving of such poles and the lines thereof, and shall pay any charges therefor.
 4. Where existing utilities are encountered along the line of Work, CONTRACTOR shall perform CONTRACTOR's operations in such a manner that service will not be interrupted, and shall, at CONTRACTOR's own expense, make all temporary provisions to maintain service.
 5. Unless otherwise indicated on Drawings, CONTRACTOR shall replace any disturbed sewer or drain, or relay same at a new grade to be established by ENGINEER, such that sufficient clearance for the sewer will be provided.
 6. CONTRACTOR will receive no extra compensation for replacement of sewers or drains encountered, or for relaying at a new grade and/or line where necessary, except where specifically noted otherwise on Drawings or Specifications.
 7. Where existing gas mains and services are encountered, CONTRACTOR shall arrange with the gas company for any necessary relaying, and shall pay for the cost of such work.
 8. Materials used in repairing or relaying utilities shall be the same type and strength as the existing Work.
- F. Storm and Sanitary Sewers: If sewers are available, CONTRACTOR may provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide portable units.
1. If gas is present in existing sewers or tanks where CONTRACTOR must work, they shall be cleared of gas before entering. If the gas cannot be removed by natural ventilation by the removal of covers, CONTRACTOR shall maintain forced draft to render the area safe as determined by gas detection equipment.
 2. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
 3. Connect temporary sewers to the municipal system as directed by the sewer department officials.
 4. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Following heavy use, restore normal conditions promptly.
 5. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains.

3.03 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

- A. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 - 1. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to OWNER.
 - 2. Provide incombustible construction for offices, shops, and sheds located within the construction area, or within 30 feet of building lines. Comply with requirements of NFPA 241.
- B. Temporary Heating Facilities: Provide temporary heat required by construction activities for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
 - 1. Except where use of the permanent system is authorized, provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control.
 - 2. Use of gasoline-burning space heaters, open flame, or salamander-type heating units is prohibited.
- C. CONTRACTOR's Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at Site. Keep the office clean and orderly for use for small progress meetings.
- D. ENGINEER's Field Office: CONTRACTOR shall provide and maintain the following type of field office for OWNER's Resident Project Representative at a point on the Site to be designated the life of the Project as listed on Bid Form. ENGINEER's field office shall be operational 3 weeks before and after each construction period or season.
 - 1. This office shall be a minimum of 8 feet by 20 feet in plan. The office shall be equipped using acceptable second-hand or on-site constructed furniture as follows:
 - a. At least four windows with provision for cross-ventilation
 - b. Securely locking exterior door.
 - c. Plan table and stool.
 - d. Two desks with drawers.
 - e. Two desk chairs.
 - f. Six electric convenience outlets.
 - g. Three wastebaskets.
 - h. Two smoke alarms.
 - i. Two 10-pound fire extinguishers for Class "ABC" fires.
 - j. One 4 cu.ft. mini refrigerator.
 - k. One microwave
 - 2. ENGINEER's field office shall be for the exclusive use of ENGINEER and shall be securely anchored for stability in high winds.
 - 3. CONTRACTOR shall provide electric or propane heat, electric air conditioning, screened and locking windows, toilet and lavatory facilities with potable water, wardrobe closet, and electric light in ENGINEER's office during the continuance of this Contract. Offices shall have a minimum of 6'-9" ceiling height.
 - a. Provide bi-weekly janitorial service in the ENGINEER's field office. Service to include maintaining toilet and lavatory facilities, replacing light bulbs, disinfecting surfaces, and cleaning the floors. Coordinate with OWNER's Resident Project Representative.

4. Four parking spaces close to ENGINEER's office shall be provided and reserved for ENGINEER.
 5. CONTRACTOR shall arrange, furnish and provide service for during the Contract Times:
 - a. Wireless internet connection either through CONTRACTOR system or separate cellular hotspot to provide continuous internet service of sufficient capacity to perform all necessary data function.
 6. As part of the Contract Price, CONTRACTOR shall provide an allowance of \$3,000 for ENGINEER to select office furnishings consisting of: computers, printer, computer equipment, software, and general office supplies as part of the Contract Price. Office furnishings purchased by ENGINEER using this Allowance shall be turned over to OWNER at final completion.
- E. Temporary Roads and Paving: Construct and maintain temporary roads and paving to adequately support the indicated loading and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with ENGINEER.
1. Comply with Section 02740 for construction and maintenance of temporary asphalt concrete paving.
 2. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.
 3. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas that are without damage or deterioration when occupied by OWNER.
 4. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.
 5. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.
- F. Sanitary Facilities: Sanitary facilities include temporary toilets, wash facilities, and drinking water fixtures. Comply with regulations and health Codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best service the Project's needs.
1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
 2. Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
 3. Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
 4. Provide safety showers, eyewash fountains and similar facilities where needed for safety and sanitation of personnel.
- G. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the Site, excavations, and construction free of water.

3.04 CONSTRUCTION BUILDINGS AND FACILITIES INSTALLATION

- A. Storage platforms, sheds, temporary closures for doors, windows and other openings of buildings, temporary sidewalks, runways, and ladders shall be provided.

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

1. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.
 2. Maintain dirt and debris resulting from CONTRACTOR's operations in designated spoil piles as approved by ENGINEER or remove from the Site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations. Excess dirt and debris shall be removed from the Site as needed to confine spoil piles in designated areas.
 3. Perform general cleanup inside of OWNER's buildings at least once every two weeks. Cleanup shall include consolidation of stored materials, removal of waste material and debris, and sweeping of flooring surfaces.
 4. Maintain clear access to all properties affected by construction activities. Maintain unobstructed access to existing buildings, equipment, safety equipment, and other items requiring OWNER access for facility operation.
 5. Keep tools, equipment, and materials in a neat and orderly arrangement.
 6. Maintain culverts, sewers, and drainage structures by removing sediment and debris from construction operations.
 7. Repair all holes and ruts resulting from construction operations that affect OWNER's use of property with approved material; compact, level, and restore.
- I. Rodent and Pest Control: CONTRACTOR shall employ a licensed pest control service during the Contract Times of this Contract.
1. Pest control service shall maintain Site free from:
 - a. Mice, rats, and similar rodents.
 - b. Termites, carpenter ants, and similar pests.
 2. Pest control services shall be performed at the start of the Project. Inspections and maintenance of pest control products shall be performed on a monthly basis.
- J. Storage of Equipment and Material: Pumps and other machinery units shall be stored in weathertight structures provided by CONTRACTOR.
1. Motors, electrical switchgear, gauges, and other equipment of a delicate nature, as determined by ENGINEER, shall be stored in weathertight warehouses which are maintained at a temperature of at least 60 degrees F.
 2. Structural steel, miscellaneous and cast iron items may be placed in open yard storage, but any such items having attached motors or other machinery units shall have such units well wrapped with waterproof paper or cloth for protection from the weather.
 3. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of ENGINEER.
 4. Materials and equipment distributed, stored, and placed upon or near the Site of the Work shall at all times be so disposed as not to interfere with work prosecuted by OWNER or other Contractors in the employment of OWNER or with drainage. Materials and equipment shall not be stored on public streets.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer as requested by ENGINEER.
- B. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10, "Standard for Portable Fire Extinguishers," and NFPA 241, "Standard for Safeguarding Construction, Alterations and Demolition Operations."
 - 1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than 1 extinguisher on each floor at or near each usable stairwell.
 - 2. Store combustible materials in containers in fire-safe locations.
 - 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
 - 4. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
- C. Barricades, Warning Signs, and Lights: Comply with Standards and Code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
- D. Enclosure Fence for the Site: When excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire Site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the Site, except by the entrance gates.
 - 1. Provide open-mesh, chain-link fencing with posts set in a compacted mixture of gravel and earth.
- E. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
 - 1. Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the Site.
- G. Control of Noise: CONTRACTOR shall eliminate noise to as great an extent as possible at all times. Air compressors shall be equipped with silencers, and the exhaust of all gasoline motors and other power equipment shall be provided with mufflers.
 - 1.

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

3.06 TRAFFIC CONTROL FACILITIES INSTALLATION

- A. Traffic Control Plan of Action: CONTRACTOR's Plan of Action shall be based upon OWNER's requirements for Traffic Control and shall detail specific detour routes including individual sign markings and locations. CONTRACTOR shall also propose CONTRACTOR's intended method for lane control within the construction Work areas. The Plan of Action shall include long-term maintenance of traffic control devices for Work that is not completed during a construction season or for extended periods when Work is not performed.
 - 1. OWNER and/or MDOT shall approve the proposed Plan of Action. Modifications to the proposed Plan of Action resulting in changes to the Bid quantities shall be adjusted as required during CONTRACTOR's submittal of monthly payment estimates.
 - 2. In addition to the Plan of Action, this Work shall consist of the furnishing, installation, operation, maintenance, and removal of the traffic control devices described in this Section.
 - 3. The location, type, and wording of warning and guide signs shall be proposed by CONTRACTOR as part of CONTRACTOR's required Plan of Action for Traffic Control.
- B. Maintenance of Traffic: During the progress of Work, CONTRACTOR shall accommodate both vehicular and pedestrian traffic as provided in these Specifications and as indicated on Drawings.
 - 1. In the absence of specific requirements, CONTRACTOR shall maintain such traffic. Access to fire hydrants, water, and gas valves shall always be maintained.
 - 2. CONTRACTOR's truck and equipment operations on public streets shall be governed by all local traffic ordinances and regulations of the Fire and Police Departments and the Department of Public Works. Work within State highway rights-of-way shall be under the jurisdiction of the Michigan Department of Transportation.
 - 3. Small street openings necessary for manholes, alignment holes, pipe connections, etc., will be permitted. Such holes shall not be open longer than necessary and shall be protected in accordance with the requirements of the local agency having jurisdiction, and any traffic detouring necessary shall be done to the satisfaction of the Agency. Whenever possible, small openings shall be covered with steel plates at pavement level and secured in place at the time that Work is being performed.
 - 4. Where streets are partially obstructed, CONTRACTOR shall place and maintain temporary driveways, ramps, bridges and crossings which, in the opinion of ENGINEER, are necessary to accommodate the public. As part of the Work under this Contract, CONTRACTOR shall be responsible for providing and maintaining flagpersons, warning lights, signs, and/or barricades, including necessary detour signs outside the Project limits as required to direct and protect vehicular and pedestrian traffic. In the event of CONTRACTOR's failure to comply with the foregoing provisions, OWNER may, with or without notice, cause the same to be done and deduct the cost of such Work from any monies due or to become due CONTRACTOR under

this Contract; but the performance of such Work by OWNER, or at OWNER's insistence, shall serve in no way to release CONTRACTOR from CONTRACTOR's liability for the safety of the traveling public.

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

3.07 SEDIMENTATION CONTROL FACILITIES INSTALLATION

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

OWNER, CONTRACTOR or subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.

C. Stormwater Discharge Control:

1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 31 of the Michigan Compiled Laws and local city or county stormwater discharge control programs.
2. CONTRACTOR shall not begin any Work at Site until the stormwater discharge permit has been obtained for the Project.
 - a. CONTRACTOR shall indemnify OWNER against any and all fines for discharge permit violations which are assessed against OWNER, and which are due to CONTRACTOR's actions or failure to maintain the sedimentation control measures.
3. CONTRACTOR shall utilize the appropriate Best Management Practices to prevent any of CONTRACTOR's activities from resulting in an unlawful discharge of pollutants to the waters of the State. CONTRACTOR shall correct any deficiencies noted by ENGINEER, Local Enforcement Agency or MDEQ within 24 hours of receiving written notice that corrections are necessary. Should CONTRACTOR fail to take action within the allotted time, OWNER shall have the right to perform the work and deduct all costs from amounts due CONTRACTOR under this Contract.

D. Dewatering Trenches and Disposal of Excess Excavated Material:

1. Pumping or draining from trench excavations shall be made on either side of the pipeline and not into the waters of the State. It shall be CONTRACTOR's responsibility to secure the necessary approval of private landowners before discharging water from the trench excavation onto private lands. Water shall be discharged in such a manner as to cause no pollution or erosion problems.
2. CONTRACTOR shall dewater to existing storm sewer systems wherever possible; method of disposal shall be approved by OWNER. All discharge from dewatering wells discharged onto the ground ahead of being piped to a natural watercourse or lake via an existing storm sewer system or by a temporary piping system shall have built at the point of entry into such storm sewer a silt retention structure.
3. The silt retention structure may consist of several straw bales adequately anchored and placed as directed by ENGINEER. Any eventual silt or solids retained in the area of these structures shall be removed prior to removal of the structure. At no time will silt or similar materials be permitted to filter into a lake or natural watercourse. There shall be no sidecasting of any excavated material into any waterway. Excess excavated material from stream crossings and excavation near streams shall be removed and disposed of elsewhere, and not within the floodplain.

E. Slope Protection: On slopes greater than 20 percent, but not immediately adjacent to stream crossing, mulch shall be anchored with a spray of asphalt, Type SS-1S emulsion mixed with an equal amount of water at a rate of 200 gallons per acre. Chemical self-adhering mulch may be used. Mulch shall be anchored on slopes greater than 10 percent if immediately adjacent to stream crossings. Mulch may also be held in place by discing with a farm disc. If mulch materials such as netting or excelsior blankets are used, they may have to be pegged.

- F. Final Topography Protection: When final topography has been established, all bared soil shall be seeded, fertilized, and mulched in an effort to restore to a protected condition, except in flat, active farm fields.
1. The permanent protection measures shall be in effect not more than 30 days after the earth change is completed, except at tie-in areas at both sides of the stream where temporary measures will be installed within 3 days following a pipeline crossing. Temporary measures may include a row of sandbags at the top of the bank, a row of pegged bales of straw, or an earth berm or diversion ditch. These temporary measures shall be maintained until permanent measures are installed.
 2. Where construction involves placing pipes in roadways or under other impervious materials, special care shall be provided by CONTRACTOR.
 3. Provide control measures at all storm sewer catch basins by providing straw or other types of filters or construct sediment traps adjacent to inlets.
 4. If a roadway has a grass ditch area, minimize disturbance and provide filter berms (straw or gravel) or sediment traps as appropriate.
 5. Provide proper down drain structures to control increased runoff to streams and drains.
 6. Stabilize the roadway as soon as possible after placement of the utility. Temporary erosion control measures shall be instituted until final paving is complete. Such measures may include a subbase surfacing application or gravel surfacing. Compaction of soil may suffice if other control measures are effected.

3.08 FIELD QUALITY CONTROL

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

3.09 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour-day basis where required to achieve indicated results and to avoid possibility of damage.
- C. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- D. Termination and Removal: Unless ENGINEER requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent

construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of CONTRACTOR. OWNER reserves the right to take possession of Project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period including, but not limited to:
 - a. Replace air filters and clean inside of ductwork and housings.
 - b. Replace significantly worn parts and parts that have been subject to unusual operating conditions.
 - c. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.

END OF SECTION

SECTION 01600 - GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 OPERATION AND MAINTENANCE

- A. All equipment suppliers shall submit to ENGINEER, through CONTRACTOR, 6 bound copies and 2 electronic/digital format copy of a manual containing specifications, Drawings, and descriptions of equipment; installation instructions; operation, maintenance, and lubrication manuals; parts lists; emergency instructions; and where applicable, test data with curves, wiring diagrams, PLC programs on CD and schematics. This information shall be submitted for each item of equipment furnished under this Contract and shall be specific to the exact equipment models complete with all appurtenances provided. It shall also include detailed, comprehensive directions for all required maintenance activities and for the repair or replacement of all wearing parts. Special attention shall be paid to necessary safety precautions that OWNER's staff should take when operating, maintaining, or repairing the equipment.
 - 1. Bound copies of O&M Manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.
 - 2. Electronic Copy of O&M Manuals: Each equipment O&M manual shall be provided with an electronic disk, matching the content of the final approved printed O&M Manual. The information shall be saved in a single ".pdf" file, with bookmarks for each chapter, section, appendices, etc., as well as each piece of equipment. Where numerous pieces of equipment may be addressed within a section, a second tier of bookmarks shall be provided to allow quick access to each piece of equipment or key piece of information.
 - 3. "Sample" Table of Contents:

Bookmarks

Table of Contents

Section 1 - Approved Shop Drawings

Section 2 - Installation Instructions and Parts Identification

Section 3 - Operations and Maintenance Information

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

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

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

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

1.03 QUALITY ASSURANCE

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

1.04 SHIPPING AND HANDLING EQUIPMENT

- A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment and handling.
- B. CONTRACTOR shall provide documentation of all preventative maintenance performed on stored equipment as required by manufacturer's O&M manuals.

1.05 SPARE MATERIALS

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

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Anchor Bolts: Anchor bolts, nuts, and washers shall be 304 stainless steel and be supplied with sleeves.
- B. Shop Painting:
 1. Non-submerged Applications: Tnemec Series 37H, Chem-Prime.
 2. Submerged, Non-potable Applications: Tnemec Series 66, Hi-Build Epoxoline.
 3. Submerged, Potable Applications: Tnemec Series 139, Pota-Pox II.

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4. Rust preventive compound shall be:
 - a. Dearborn Chemical, No-Ox-ID2W.
 - b. Houghton, Rust Veto 344.
 - c. Rust-Oleum R-9.

2.02 MANUFACTURED UNITS

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

2.03 COMPONENTS

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

drain connection. Bases shall be fully braced to withstand shock loads and resist buckling. Necessary safety guard mounting shall be provided as part of the equipment base.

- G. Motor Starters and Control Panels: Motor starters 480 volt or less shall be size one or larger and have 120 volt AC contactor coils. All control circuits and indicating lights associated with the starter shall be 120 volt. The control transformer shall be sized to have 100 VA minimum spare capacity for future use. A terminal strip shall be provided for all control wires entering the starter with spare terminals for future use. The terminal strip and wires shall be identified. One spare normally open auxiliary starter contact, wired to the terminal strip, shall be provided for future use. Indicating lights shall be 120 volt, oiltight, push-to-test type. Explosion-proof units shall meet NEC Class I, Division I, Group D requirements.
 - 1. Provide equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction, such as NEMA 4, 4X, 7, or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
- H. Variable Frequency Drive: Supplier shall coordinate requirements for Variable Frequency Drives with requirements list in Equipment Specifications, Section 16422, and ALL ELECTRICAL AND INSTRUMENTATION DRAWINGS.

2.04 FABRICATION

- A. Shop Painting: All iron and steel surfaces shall be protected by suitable paint or coatings applied in the shop or at point of fabrication. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment.
 - 1. All iron and steel surfaces which will be totally or partially submerged or located in a continuously or intermittently moist atmosphere during normal operation shall be shop blast cleaned to a near-white finish, removing all dirt, rust-scale, and foreign matter by any of the recommended methods outlined in the Steel Structures Painting Council Specification SP-10.
 - 2. The cleaned surfaces shall be shop primed before any rust bloom forms. All other exposed surface shall be properly filed, scraped, sanded, etched, brushed, sandblasted, and/or cleaned to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease and shop primed.
 - 3. Shop primed surfaces shall be painted with one or more coats of a primer which meets the requirements of this Section and is compatible with the finish painting system specified in Section 09961. Minimum shop coat thickness shall be 1.5 dry mills.
 - 4. Shop painting colors shall meet the color code in Section 09961.
- B. Sluice gates shall be factory painted with coal tar.
- C. The exterior surfaces of all ground-buried valves shall receive a coal tar or bituminous coating in accordance with manufacturer's standards. The inside surfaces of all valves shall be coated with coal-tar pitch varnish in accordance with the latest AWWA Specifications.
- D. Electric motors, speed reducers, starters, pumps, motor control centers, control panels, and other self-contained or enclosed components shall be shop finished with 2 coats of an enamel paint as per manufacturer's recommendations.
- E. Where specified, steel and iron surfaces shall be hot-dipped galvanized in conformity with ASTM A 153 and A 385.

- F. Machined, polished, and nonferrous surfaces which are not to be painted or galvanized shall be coated with rust preventive compound.

PART 3 - EXECUTION

3.01 EQUIPMENT BASES

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

3.02 WALL AND SLAB SLEEVES AND CASTINGS

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

3.03 EQUIPMENT INSTALLATION CHECK

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

3.04 OPERATION AND MAINTENANCE TRAINING

- A. Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing

and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.

1. Manufacturer's representative shall provide a minimum of 2 days on-Site training.
 - a. At least two sessions of training for Operations personnel. Training shall take place on a Tuesday at 8:00 am and Thursday at 3:00 pm.
 - b. One session for Maintenance, Electrical and Instrumentation personnel.
2. Training will not be scheduled until OWNER has approved final O&M manuals and a training outline of the items to be covered including key performance indicators, normal operation guide, control and alarm set points, safety, emergency procedures, basic system curves, etc.
3. Equipment shall be operational.
4. Review operating and maintenance data contained in the operating and maintenance manuals.
5. Schedule training with OWNER and ENGINEER, provide at least 7-day prior written notice to ENGINEER.

END OF SECTION

SECTION 01730 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for cutting and patching.
- B. Related Sections:
 - 1. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work. Requirements of this Section apply to mechanical and electrical installations. Refer to Division 15 and Division 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.
 - 2. Demolition of selected portions of the building for alterations is included in Section 02225.
- C. CONTRACTOR shall take precautions that all existing piping and equipment paint may contain lead paint.

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 PREPARATION

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

3.03 PERFORMANCE

- A. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
- B. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
- C. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with the original installer's recommendations.
 - 1. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
 - 4. Use of cutting torches on surfaces known to contain lead paint is prohibited. Cutting shall be performed in a manner to prevent airborne exposure to lead paint. The paint shall be removed in a 4-inch wide stripe, in the area to be cut, by hand tool or chemical means prior to the cutting of the pipe.
- D. Comply with requirements of applicable Sections of Division 2 where cutting and patching requires excavating and backfilling.

- E. Cap, valve or plug, and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.
- F. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
 - 2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - 3. Patch, repair or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.04 CLEANING

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

END OF SECTION

SECTION 01770 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 WARRANTY REQUIREMENTS

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

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

1.03 SUBSTANTIAL COMPLETION

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

1.04 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
 - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.

2. Submit an updated final statement, accounting for final additional changes to the Contract Price.
 3. Submit a copy of ENGINEER's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by ENGINEER.
 4. Submit to OWNER furnished consent of surety to final payment.
 5. Submit a final liquidated damages settlement statement.
 6. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 7. Submit record drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information.
 8. Deliver tools, spare parts, extra stock, and similar items.
 9. Make final changeover of permanent locks and transmit keys to OWNER. Advise OWNER's personnel of changeover in security provisions.
 10. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- B. Reinspection Procedure: ENGINEER will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to ENGINEER.
1. Upon completion of reinspection, ENGINEER will prepare a certificate of final acceptance, or advise CONTRACTOR of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated.

1.05 SUBMITTALS

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

1.06 RECORD DOCUMENT SUBMITTALS

- A. Record Drawings:
 1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown.

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 COMPONENT ACCEPTANCE

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

3.02 FINAL CLEANING

- A. General cleaning during construction is required by the General Conditions and included in Section 01500.
- B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

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

END OF SECTION

SECTION 02225 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

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

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Proposed dust control measures.
 - 2. Proposed noise control measures.
 - 3. Proposed haul routes between Site and disposal areas before commencing this Work.
- B. Submit Schedules listed below to OWNER.
 - 1. Detailed sequence of selective demolition and removal Work, with starting and ending dates for each activity.

2. Inventory list of removed existing equipment not reused in Contract Work. Submit lists to OWNER. OWNER to determine or select items for retention by OWNER.
 3. Inventory list of removed and salvaged items.
 4. Inventory list of OWNER-removed items.
 5. Interruption of utility service.
 6. Coordination for shutoff, capping, and continuation of utility services.
 7. Use of elevator and stairs.
 8. Detailed sequence of selective demolition and removal Work to ensure uninterrupted progress of OWNER's on-Site operations.
 9. Coordination of OWNER's continuing occupancy of portions of existing building and of OWNER's partial occupancy of completed Work.
 10. Locations of temporary partitions and means of egress.
- C. Inventory list of existing equipment to be removed and not reused in Work. OWNER to determine or select items for retention by OWNER. OWNER reserves right to retain any and all equipment or material removed under this contract. CONTRACTOR is responsible to haul and dispose of all remaining equipment, piping, conduit, materials, debris, etc. not retained by OWNER at a proper disposal facility in accordance with all regulations.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Disassemble or cut large equipment items into smaller pieces to promote safe removal and transportation.
1. Transport and unload items requested by OWNER at designated Site within distance of 5 miles.
 2. Haul away and dispose of debris and materials neither retained by OWNER, nor reused or reinstalled.
 3. Arrange for disposal areas.
 4. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

- B. Unloading Salvage Items: Where shown on Drawings as "Remove and Salvage," carefully remove shown items, clean, store, and turn over to OWNER and obtain receipt. OWNER will designate site for receiving items.
- C. Handling: CONTRACTOR shall take every precaution to prevent spillage of materials being hauled in public streets.
 - 1. It shall be CONTRACTOR's responsibility to immediately clean spillage that may accidentally occur.
 - 2. Do not burn removed material on or within Project Site.

1.06 PROJECT CONDITIONS

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

1.07 SEQUENCING

- A. Conduct selective demolition Work in manner that minimizes need for disruption or interference of OWNER's normal on-Site operations.

- B. Coordinate with OWNER's continuing occupation of portions of existing building, with OWNER's partial occupancy of completed new addition and OWNER's reduced usage during summer months.
- C. Include coordination for shutoff, capping, and continuation of utility services together with details for dust and noise control protection to ensure uninterrupted on-Site operations by OWNER.

1.08 SCHEDULING

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Before beginning selective demolition Work, inspect areas of Work. Survey existing conditions and correlate with requirements shown to determine extent of selective demolition required. Photograph existing structure surfaces, equipment, or surrounding properties which could be misconstrued as damage resulting from selective demolition Work. File with OWNER's Representative before starting Work.
- B. Inventory and record condition of items scheduled as "remove and re-install" or items scheduled as "remove and salvage."
- C. Verify disconnection and capping of utilities within the affected area of Work.
- D. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design, investigate and measure nature and extent of conflicts. Promptly submit detailed written reports to OWNER's Representative. Pending receipt of the directive from OWNER's Representative, rearrange selective demolition schedule to continue general job progress without delay.

3.02 UTILITY SERVICES

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

3.03 PREPARATION

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

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

3.04 DEMOLITION

- A. Special Techniques: Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. Use of cutting torches on surfaces known to contain lead paint is prohibited. Cutting shall be performed in a manner to prevent airborne exposure to lead paint. The paint shall be removed in a 4-inch side stripe, in the area to be cut, by hand tool or chemical means prior to the cutting of the pipe.
- C. Demolish foundation walls to depth of not less than 12 inches below proposed ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.
- D. For interior slabs on grade, use power saw or removal methods that do not crack or structurally disturb adjacent slabs or partitions.
- E. Completely fill below-grade areas and voids resulting from selective demolition Work. Either:
 - 1. Provide fill consisting of approved earth, gravel, or sand.
 - 2. Fill shall be free of trash, debris, stones over 6-inch diameter, roots, or other organic matter.
- OR
- 3. Fill below-grade areas and voids with Class F concrete.
- F. Explosives: Use of explosives is not allowed.
- G. Interface with Other Work: Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
- H. Site Tolerances: Provide services for effective air and water pollution controls required by local authorities having jurisdiction.

3.05 REPAIR\RESTORATION

- A. Repair damages caused by demolition that was more extensive than required.
- B. Return structures and surfaces to condition existing before commencement of selective demolition Work.
- C. Repair adjacent construction or surfaces soiled or damaged by selective demolition Work.

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- D. Promptly repair damages caused to adjacent facilities by selective demolition Work at no cost to OWNER.

3.06 CLEANING

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

END OF SECTION

SECTION 02805 - RESTORATION WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Work including the replacement of all permanent type roadway bases and surfaces, concrete sidewalks, curbs and gutters, trees, lawns, and driveways damaged or removed due to the construction of the pipe and appurtenant structures. All such Work shall be in accordance with the Best Modern Practice, OWNER's standards, and/or as specified herein.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 REFERENCES

- A. Michigan Department of Transportation (MDOT):
 - 1. 4.00 Construction Mix Designs.
 - 2. 4.00.04 Trench Surface Conditioning.
 - 3. 4.06 Bituminous Seal Coats.
 - 4. 4.06.06 Bituminous Seal Coats.
 - 5. 4.06.09 Application of Cover Material.
 - 6. 4.06.10 Weather Limitations.
 - 7. 4.06.12 Maintenance of Surface.
 - 8. 6AA Coarse Aggregate.
 - 9. 7.10 Plant Hot Mix Method.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Material Certificates: Provide copies of materials certificates signed by materials producer and CONTRACTOR, certifying that each materials item complies with or exceeds specified requirements.
- B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. Certification: CONTRACTOR shall submit certificates of compliance with applicable MDOT Standard Specifications.

1.05 SITE CONDITIONS

- A. Weather Conditions: Construct asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. Bituminous base course over 2 inches thick may be placed when air temperature is above 35 degrees F (-1 degree C) and rising. Asphalt may not be placed between November 15 and May 5.

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1.06 WARRANTY

- A. Special Warranty: Provide, in accordance with Section 01770, warranties covering the items included under this Section.
 - 1. Warranty Period: 1 year from the time of planting.
 - 2. This warranty includes furnishing new plants as well as labor and materials for installation of replacements. Replacement plantings shall meet or exceed all requirements for original plant materials as specified herein.
 - 3. CONTRACTOR shall not assume responsibility for damages or loss of plants or trees caused by fire, flood, lightning storms, freezing rains, winds over 60 miles per hour, or vandalism.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE

- A. Aggregate base shall be constructed with not less than 12 inches of compacted aggregate placed in two 6-inch layers. Aggregate base shall meet requirements of MDOT Specification for 21A or 22A aggregate. Aggregate base shall extend beyond pavements to match existing aggregate or a minimum of 24 inches.

2.02 AGGREGATE SURFACE

- A. Aggregate surface shall be constructed with not less than 12 inches of aggregate placed in two 6-inch layers. Aggregate surface shall meet MDOT Specification No. 22A.

2.03 BITUMINOUS BASE

- A. Bituminous base shall have a completed thickness of 8 inches, placed and compacted in two 4-inch layers. Bituminous base shall meet the requirements of Bituminous Mixture No. 500-20C of MDOT Specification 7.10. Asphalt cement shall have an asphalt penetration (viscosity) rate of 120-150. A bituminous bond coat meeting MDOT Specification SS-1h or MS-2a shall be applied to each succeeding layer of bituminous material at the rate of 0 - 0.10 gallon per square yard.

2.04 BITUMINOUS PAVEMENT

- A. Bituminous pavement shall be one of the following types:
 - 1. Type A: 1-1/2-inch, No. 1100L-20AA, leveling course over aggregate base with 1-1/4-inch, No. 1100T-20AA, wearing course in trench areas.
 - 2. Type B: 1-1/2-inch, No. 1100L-20AA, leveling course over aggregate base in trench areas with 1-1/2-inch, No. 1100T-20AA, wearing course over entire width of pavement.
 - 3. Type C: 1-1/2-inch, No. 1100T-20AA, wearing course on 8-inch concrete base in trench areas.
 - 4. Type D: 1-1/2-inch, No. 1100T-20AA, wearing course in trench areas over bituminous base course No. 500-20L.
- B. Bituminous mixtures shall be furnished and placed in accordance with MDOT Specification 7.10 with no restriction for the "Aggregate Wear Index."

- C. Asphalt cement shall have an asphalt penetration (viscosity) rate of 120-150. Aggregate required shall be 20AA. When tested at the optimum asphalt content in accordance with ASTM D 1559, the bituminous mixture shall meet the requirements for stability; 1,100 pounds; flow, 8-18 hundredths of an inch; and voids in mineral aggregate, 15.0 percent, as specified in Table 7.10-1 of MDOT Specifications. The maximum allowable deviations permitted from the approved Job-Mix Formula shall be as shown in Table 7.10-3 of MDOT Specifications.
- D. At CONTRACTOR's expense, a qualified laboratory shall furnish ENGINEER a Job-Mix Formula in accordance with above criteria. After Job-Mix Formula is established, the aggregate gradation and the bitumen content of the bituminous mixture furnished for Work shall be maintained within the uniformity tolerance limits permitted in Table 7.10-3, and within the master gradation range as specified in Table 7.10-2 of MDOT Specifications.

2.05 CONCRETE DRIVEWAYS

- A. All concrete driveways removed shall be replaced with Class P concrete, 6 inches thick. All driveways replaced shall have welded wire fabric, 6-inch by 6-inch, W1.4 by W1.4, for the full extent of new concrete paving. Joints shall be as specified in concrete work and/or concrete pavements.

2.06 CONCRETE CURB AND GUTTER

- A. Concrete curb and gutter to be replaced shall have the same cross-section as that removed, or as shown on Drawings, using Class P concrete and in accordance with OWNER's standards.

2.07 CONCRETE SIDEWALKS

- A. Concrete sidewalks shall be replaced with walks 4 inches thick (6 inches thick at driveway crossings) and to the same width as the existing walks. Concrete shall be Class B.

2.08 CONCRETE RAMPS

- A. Ramps shall be constructed 6 inches thick and to the width and slope shown on Drawings using Class B concrete. Type of ramp shall be as noted on Drawings for different intersection conditions.

2.09 SEEDING

- A. Seeding shall be one of the following types:
 - 1. Sodded Shoulders, Slope Area, or Flat Field: 4 inches of topsoil, 20 pounds of 10-6-4 commercial fertilizer per 1,000 square feet of area, and 5 pounds of MDOT mixture roadside per 1,000 square feet of area.
 - 2. Flat Lawn Area: 4 inches of topsoil, fertilizer as specified above and 3 pounds of MDOT mixture Class A per 1,000 square feet of area.
- B. Sod: Provide strongly rooted sod, not less than 2 years old, free of weeds and undesirable native grasses, and machine cut to pad thickness of 3/4 inch (plus or minus 1/4-inch), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant). Peat sod will not be acceptable.
 - 1. Provide sod of uniform pad sizes with maximum 5 percent deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting

- their own weight when suspended vertically with a firm grasp on upper 10 percent of pad will be rejected.
2. Provide sod composed principally of following:
 - a. Mixed Kentucky Bluegrass (*Poa pratensis*).

PART 3 - EXECUTION

3.01 COORDINATION OF WORK

- A. Type of restoration shall be as noted on Drawings regardless of existing surface.
- B. The placing of base and surface courses shall follow immediately after backfilling the trench so that not more than 600 feet of length of trench shall be incomplete at one time. If areas of trench in excess of 600 feet are left incomplete, CONTRACTOR shall provide such necessary temporary roadway surface as directed by ENGINEER. Any material placed in the trench other than that specified shall be considered as a temporary surface and shall be removed. No payment will be allowed for temporary roadway construction.
- C. All utilities, such as catch basins, manhole castings, water valve boxes, etc., shall be adjusted prior to installation of new pavement so that the finished surface will meet such utilities smoothly when surfacing is completed.

3.02 SAW CUT JOINTS

- A. Damaged areas shall be removed by sawing a straight-cut parallel with longitudinal and transverse construction or contraction joints. No saw cuts shall be nearer than 5 feet to a longitudinal or transverse joint or to the edge of the pavement. If the damaged area is less than 5 feet from an existing joint, the existing surface shall be saw-cut 5 feet from the damaged area, removed, and replaced. If the damaged area is less than 5 feet from the edge of the pavement, the removal and replacement shall be extended to said edge of pavement.
- B. Saw cutting of concrete shall be done with a carborundum saw to a minimum depth of half the slab thickness or that depth required to cut reinforcing steel. Bituminous surfaces shall be cut full depth.
- C. After the trench is backfilled and before the pavement over the trench is replaced, all angular and ragged irregularities on the edges of the cut pavement shall be removed giving a smooth and regular edge of pavement. Payment for cut joints required shall be included under the unit price of pavement restoration.

3.03 EXCAVATION

- A. Before repaving is started, all trenches and area around structures shall be excavated or backfilled to the level of the subgrade as required by the type of pavement replacement and cross-section specified. All existing pavement that has been undercut by the excavation for the pipe or structures shall be removed. The finished subgrade shall be smoothed, trimmed, and compacted to the required grade and cross-section. Compaction of the finish subgrade shall be obtained by suitable means approved by ENGINEER.

3.04 AGGREGATE BASE

- A. Place aggregate base on a prepared subbase or subgrade in accordance with construction methods described in Section 3.01 of MDOT Specifications.

3.05 AGGREGATE PAVEMENTS

- A. Aggregate surfaces shall be replaced with aggregate. After placing aggregate, this surface shall immediately be opened to traffic and as holes and ruts appear, they shall be filled with aggregate and the surface shall be maintained as a smooth, dust-free street surface until Work is accepted by ENGINEER and OWNER.

3.06 BITUMINOUS BASE

- A. Place bituminous base on a prepared subbase or subgrade in accordance with construction methods described in Division 4 of MDOT Specifications.

3.07 BITUMINOUS PAVEMENTS

- A. Pavement surfaces shall be replaced with bituminous concrete of the type and in locations shown on Drawings. Work shall consist of saw cutting existing surfaces as herein specified under Saw Cut Joints, conditioning and treating the base course with prime or bond material and constructing thereon a bituminous concrete surface consisting of mineral aggregate, mineral filler, and bituminous material combined by a plant hot mix method per MDOT Specification. Construction methods and equipment for placing bituminous materials shall be as specified in MDOT Standard Specifications.
- B. Pavement surfaces shall be replaced to match existing widths but new pavements shall not be less than 22 feet wide.
- C. Conditioning of Base: Bituminous base shall be treated with a bond coat applied at the rate of 0 - 0.10 gallon per square yard. Bond coat shall be SS-1h or MS-2a.
- D. Leveling Course: Bituminous leveling course mixture shall be placed in one or more layers to the cross-section shown on Drawings. When the total application rate exceeds 220 pounds per square yard, the leveling course shall be applied in 2 courses. A bond coat shall be applied at the rate of 0 - 0.10 gallon per square yard between courses.
- E. Wearing Course: Following completion of the leveling course or courses, the surface shall be treated with a bond coat of 0 - 0.10 gallon per square yard. The wearing course mixture shall be placed according to the cross-section shown on Drawings in one or more courses as required.
- F. All joints in the bituminous pavements shall be vertical joints. Where the joints are allowed to set before the adjoining pavement is placed, such joints shall be treated with bond coat material.
- G. Feathering to connect new pavement to an existing pavement will not be allowed.

3.08 CONCRETE CONSTRUCTION

- A. Pavement: The surface of concrete pavements shall be properly consolidated and struck off to such elevations so as to match adjacent pavement and made uniform by transverse floating. As soon as all

excess moisture has disappeared, the pavement shall be given a final light brooming finish by dragging a seamless strip of damp burlap or cotton fabric. Edges of all joints shall be tooled.

1. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.
- B. Curb and Gutter: Concrete curb and gutter shall be placed prior to the placement of other types of roadway surfaces including concrete pavements.
1. Curb and gutter to be replaced shall be determined by ENGINEER and shall include any cracked or broken sections and any sections which have settled 0.25 inch or more.
 2. Forms shall be complete front and back type. Back forms resulting in hand forming the curb and gutter will not be allowed. Forms shall be of metal, straight and free of distortion and of sufficient strength to resist springing during the placing of concrete. Forms shall be securely staked, braced, and tied to the required line and grade. Flexible steel or adequately sized lumber may be used for short radius forms.
 3. One-inch expansion joints shall be placed opposite expansion joints in an abutting pavement. If curb or curb and gutter do not abut a concrete pavement, place expansion joints at all spring lines of street returns. If intersecting streets are more than 300 feet apart, place expansion joints at 200-foot intervals. For MDOT Standard Details A, B, C5, C6, and D curb and gutter, place expansion joints in abutting pavement.
 4. If the structure does not abut a concrete pavement or base, contraction joints shall be placed at approximately 100-foot intervals.
 5. Intermediate plane of weakness joints shall be placed at approximately 10-foot intervals between other joints as called for above.
 6. Curb returns and curb cuts for driveways shall be installed as required.
 7. The gutter and top of curb shall not vary more than 3/16 inch in 10 feet when checked with a 10-foot straightedge.
 8. After the back forms are removed, honeycomb and minor defects shall be filled with mortar, composed of 1 part Portland cement and 2 parts sand.
 9. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.
- C. Sidewalks: Forms shall be of metal or wood, straight and free of distortion, and of sufficient strength to resist springing during the placing of concrete. Forms shall be securely staked, braced, and tied to the required line and grade. Flexible steel or adequately sized lumber may be used for short radius forms.
1. The walk subgrade shall be compacted to 95 percent compaction by tamping. After wetting the subgrade, the concrete shall be placed to the proper depth and spaded along the form faces.
 2. Concrete shall be alternately tamped and screeded until all voids are removed and the surface has been brought to the required grade. The surface shall then be floated to produce a smooth, dense surface, free from irregularities. All edges and joints shall be rounded to a radius of 1/4 inch with an edging tool and trowel. As soon as all excess moisture has disappeared, the surface shall be finished by light brooming.
 3. Walks shall be divided into blocks approximately square, using slab division forms or by cutting joints after floating. These joints shall be 1/2-inch-deep by 1/8- to 1/4-inch in width, and shall be finished smooth and true to line. Bituminous expansion joints shall be provided at intervals of 50 feet and at junctions with structures and curbs. Control joints shall be located between expansion joints at intervals equal to the sidewalk width.

4. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.

3.09 SEEDING

- A. Wherever the pipe trench passes through an area to be seeded, the backfilling shall be carried up to the surface except the top 4 inches, which shall be selected topsoil preserved or secured elsewhere for this purpose. This topsoil shall be rich, black surface earth, free from sod, weed stalks, or debris. The trench surface shall be carefully raked to an even surface, and all stones, sticks and other debris removed therefrom.
- B. Seeded areas shall receive a proper mulch of chopped straw, jute matting, or woven Kraft paper yarn. Seed shall not be sown between June 15 and August 15, or between October 15 and April 15, or at any time when the soil has insufficient moisture to ensure proper germination, or CONTRACTOR shall provide sufficient application of water by sprinkling until a growing catch of grass is established.

3.10 RECONDITIONING EXISTING LAWNS

- A. Recondition existing lawn areas damaged by CONTRACTOR's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.
- B. Provide fertilizer, seed or sod, and soil amendments as specified for new lawns, and as required, to provide a satisfactorily reconditioned lawn.
- C. Provide new topsoil, as required, to fill low spots and meet new finish grades.
- D. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.
- E. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from CONTRACTOR's operations, including oil drippings, stone, gravel, and other loose building materials.
- F. Where substantial lawn remains but is thin, mow, rake, aerate if compacted, fill low spots, remove humps, and cultivate soil, fertilize, and seed. Remove weeds before seeding, or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
- G. Water newly planted lawn areas and keep moist until new grass is established.

3.11 PROTECTION

- A. Protection and Maintenance: CONTRACTOR shall assume responsibility for maintaining CONTRACTOR's Work to the end of the guarantee period. During this period, CONTRACTOR shall make a minimum of 1 maintenance trip every 4 weeks during the growing season, and as many more as necessary to keep the plantings in a thriving condition.

1. Maintenance of plants shall consist of pruning, cultivating, weeding, watering, keeping guying taut and trees erect, raising tree balls which settle below grade, and providing such sprays as are necessary to keep the planting free of insects and diseases.
- B. Acceptance: At the end of the warranty period, final acceptance will be made by ENGINEER and OWNER, provided all requirements of the Specifications have been fulfilled.
 1. Inspection of the plantings will be made jointly by CONTRACTOR and ENGINEER at completion of planting. All plants not in a healthy growing condition shall be removed and replaced with plants of like kind, size, and quality as originally specified before close of next planting season.

END OF SECTION

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03200 - Reinforcing Steel
- B. Section 03250 - Concrete Accessories
- C. Section 03290 - Joints in Concrete
- D. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 301 - Specifications for Structural Concrete for Buildings
 - 4. ACI 347 - Recommended Practice for Concrete Formwork
 - 5. U.S. Product Standard for Concrete Forms, Class I, PS 1
 - 6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Manufacturer's data on proposed form release agent
 - 2. Manufacturer's data on proposed formwork system including form ties

1.05 QUALITY ASSURANCE

- A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 - PRODUCTS

2.01 FORMS AND FALSEWORK

- A. All forms shall be smooth surface forms unless otherwise specified.

- B. Wood materials for concrete forms and falsework shall conform to the following requirements:
 - 1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.
 - 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.
- C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.
- C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

2.03 FORMWORK LINERS

- A. Formwork liners for construction of fluted wall treatment shall be prefabricated plastic liners as manufactured by Greenstreak, Interform Company, or Symons Corporation.
- B. Liners shall be fiberglass or ABS (acrylonitrile – butadiene – styrene) of such configuration as to obtain the fluted pattern shown or indicated on the Drawings.
- C. For purposes of designating type and quality of material required, form liners shall be pattern 361 trapezoidal liners as manufactured by Greenstreak.
- D. Preparation of forming materials, sealing of joints to prevent grout leakage and form release treatment (if required) shall be in strict compliance with the manufacturer's printed instructions and recommendations.

PART 3 - EXECUTION

3.01 FORM DESIGN

- A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.
- B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

- A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.
- B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.
- C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.
- D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.
- E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where

the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

- F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.
- G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.
- H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.
- I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.
- J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

- A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.
- C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be

maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

- D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

3.04 FORM ACCESSORIES

- A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.
- B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to wastewater or enclosed surfaces above the wastewater, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION - FORM RELEASE AGENT

- A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

- A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

- A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

- A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has achieved 28-day compressive strength, unless approved by Engineer. Additional concrete test cylinders used for shoring removal, as required, shall be cured on site. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
- B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

Minimum Time Forms are to Remain in Place:

Part of Structure	Average Air Temperature* During Period	
	40 - 50 degrees F	>50 degrees F
Walls, columns and sides of beam (hours)	72	24
Bottom forms for slabs, beams arches not reshored (days)	12	7
Bottom forms for slabs, beams and arches if reshored (days)	7	4

* Air temperature near form.

- C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.
- D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

3.09 RESHORING

- A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.
- B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

- C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.
- D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and, in all cases, shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.
- E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

END OF SECTION

SECTION 03200 - REINFORCING STEEL

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.
- B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code
 - 2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
 - 3. ACI SP66 - ACI Detailing Manual
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcing
 - 5. ACI 318 - Building Code Requirements for Structural Concrete
 - 6. WRI - Manual of Standard Practice for Welded Wire Fabric
 - 7. ASTM A 185 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcing
 - 8. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.
 - 2. Mill test certificates - 3 copies of each.
 - 3. Description of the reinforcing steel manufacturer's marking pattern.
 - 4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
 - 5. Proposed supports for each type of reinforcing.

6. Request to use splices not shown on the Drawings.
7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.
8. Request for placement of column dowels without the use of templates.
9. Request and procedure to field bend or straighten partially embedded reinforcing.

1.05 QUALITY ASSURANCE

- A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

PART 2 - PRODUCTS

2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade.
- B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 185 and the details shown on the Drawings.
- C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.
- D. Field welding of reinforcing steel will not be allowed.
- E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Slab bolsters shall have gray plastic-coated legs.
- B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

- A. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

- B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.
- C. Hot-forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

2.04 DOWEL ADHESIVE SYSTEM

- A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and reinforcing bar. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. The embedment depth of the bar shall be per manufacturer's recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. The adhesive system shall be "HILTI RE500 -SD " or HILTI-HY 200" as manufactured by HILTI. Epcon System C6 or G5" as manufactured by ITW Redhead. "SET Epoxy-Tie" or "SET-XP" as manufactured by Simpson Strong-Tie Co. or "PE-1000 SD" and "T308" by Powers Fasteners. Engineer's approval is required for use of this system in locations other than those shown on the Drawings. Fast-set epoxy formulations shall not be acceptable.
- B. Where identified on the Contract Drawings or for installation of concrete where anchorage failure could present a life-threatening hazard, the adhesive system shall be "PE-1000 SD" by Powers Fasteners, "SET-XP" by Simpson Strong-Tie Co. or "Epcon System G5" as manufactured by ITW Redhead. Alternate adhesive systems shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories, must comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. Installation of adhesive system shall be per manufacturer's recommendations and as required in Item A above.

PART 3 - EXECUTION

3.01 TEMPERATURE REINFORCING

- A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
- B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.
- C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved by the Engineer to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.
- D. Welded wire fabric shall be furnished in flat sheets only.

3.03 DELIVERY, STORAGE AND HANDLING

- A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.
- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 PLACING

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.
- B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

- D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.
- E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.
- F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.
- G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.
- H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings or authorized in writing by the Engineer. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.
- I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations. A representative of the manufacturer must be on site when required by the Engineer. At least 25 percent of the dowels installed shall be proof tested to 1.33 times the allowable load specified by the manufacturer, or as indicated on the Drawings. If the dowels are required to have a hook at the end to be embedded in the new work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate the testing.

3.05 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.
- B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.
- E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.06 INSPECTION

- A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.
- B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

END OF SECTION

SECTION 03250 - CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, epoxy bonding agent, and concrete anchors.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03290 - Joints in Concrete
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Sealers

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. Federal Specification TT-S-00227 E (3)
 - 2. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 3. ASTM D412 Standard Tests for Rubber Properties in Tension
 - 4. ASTM D 624 Standard Test method for Rubber Property - Tear Resistance
 - 5. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
 - 6. ASTM D1751 Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types)
 - 7. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Manufacturer's literature on all products specified herein including material certifications.
 - 2. Proposed system for supporting PVC waterstops in position during concrete placement
 - 3. Samples of products if requested by the Engineer.

PART 2 - PRODUCTS

2.01 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07900, Joint Sealers.

2.02 EXPANSION JOINT MATERIAL

- A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:
1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.
 2. Type II - Cork, conforming to ASTM D1752, Type II.
 3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.
 4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

2.03 EXPANSION JOINT SEAL

- A. Expansion Joint Seal System shall consist of a preformed backer rod, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

2.04 CONCRETE ANCHORS

A. Mechanical Anchors:

1. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt" or "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.
2. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
3. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.
4. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners

B. Adhesive Anchors:

1. Adhesive anchors shall be "Epcon G5" by ITW Redhead, "HIT HY-200" or RE 500-SD by Hilti, Inc., "SET-XP" by Simpson Strong-Tie Co., or "Powers 1000+" by Powers Fasteners.
2. Adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. No "or equal" products will be considered unless prequalified and approved by the Engineer and Owner.

C. Concrete Anchor Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
3. Nuts, washers, and other hardware shall be of a material to match the anchors.

PART 3 - EXECUTION

3.01 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

- A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.
- B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.
- C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.
- E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.
- F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.
- G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.02 EXPANSION JOINT SEAL

- A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

3.03 ANCHOR INSTALLATION

A. Concrete Anchors and Masonry Anchors

1. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
3. Concrete anchors shall not be used in place of anchor bolts without Engineer's approval.
4. All stainless steel threads shall be coated with antiseize lubricant.

B. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days.
2. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
3. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. No cored holes shall be allowed unless specifically approved by the Engineer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and threaded rod/bolt unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling.

C. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
2. All stainless steel bolts shall be coated with antiseize lubricant.

END OF SECTION

SECTION 03290 - JOINTS IN CONCRETE

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.
- B. Types of joints in concrete shall be as follows:
 - 1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.
 - 2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.
 - 3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Sealers

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Structural Concrete
 - 3. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Layout drawings showing location and type of all joints to be placed in each structure.
 - 2. Details of proposed joints in each structure.

PART 2 - MATERIALS

2.01 MATERIALS

- A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Sealers.

PART 3 - EXECUTION

3.01 CONSTRUCTION JOINTS

- A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.
- B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25'-0".
- D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.
- E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.
- F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

3.02 EXPANSION JOINTS

- A. Size and location of expansion joints shall be as shown on the Drawings.
- B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

3.03 CONTRACTION JOINTS

- A. Location of contraction joints shall be as shown on the Drawings.

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- B. Contraction joints shall be formed with contraction joint inserts as specified in Section 03250, Concrete Accessories.
- C. Sawcutting of contraction joints in lieu of forming will not be allowed unless otherwise noted on the Drawings. Where sawcutting is allowed, joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.
- D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.04 JOINT PREPARATION

- A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.
- C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.
- D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.
- B. The requirements in this section shall apply to the following types of concrete:
 - 1. Class A1 Concrete: Normal weight structural concrete to be used in all structures, sidewalks and pavements, except where noted otherwise in the Contract Documents. All concrete shall be Class A1 concrete unless another class is specifically called for on Contract Documents or specified herein.
 - 2. Class A2 Concrete: Normal weight structural concrete to be used for interior slabs where a concrete hardener is required for application after placement of slab.
 - 3. Class A3 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or where specifically requested by Contractor and approved by Engineer. Class A3 concrete shall be similar to Class A1 except Class A3 concrete shall contain a mandatory addition of high range water reducer to aid in placement of concrete.
 - 4. Class A4 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A4 concrete is identical to Class A1 concrete except that coarse aggregate specified in Article 2.05 below shall be Size #8 in accordance with ASTM C33. Class A4 concrete may also require a mandatory addition of high range water reducer to aid in placement of concrete.
 - 5. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, and other areas where specifically noted on Contract Drawings.
 - 6. Class C Concrete: Normal weight concrete to be used where specifically called for on Contract Drawings for fill below structures.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03200 - Reinforcing Steel
- C. Section 03250 - Concrete Accessories
- D. Section 03290 - Joints in Concrete
- E. Section 03350 - Concrete Finishes
- F. Section 03370 - Concrete Curing

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
1. International Building Code
 2. ACI 214 Recommended Practice for Evaluation of Strength Test Results of Concrete
 3. ACI 301 Specifications for Structural Concrete for Buildings
 4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
 5. ACI 305 Hot Weather Concreting
 6. ACI 306 Cold Weather Concreting
 7. ACI 309 Recommended Practice for Consolidation of Concrete
 8. ACI 318 Building Code Requirements for Structural Concrete
 9. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
 10. ACI 350.1 Specification for Tightness Testing of Environmental Engineering Concrete Structures
 11. ASTM C 31 Standard Methods of Making and Curing Concrete Test Specimens in the Field
 12. ASTM C 33 Standard Specification for Concrete Aggregates
 13. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 14. ASTM C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 15. ASTM C 88 Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
 16. ASTM C 94 Standard Specification for Ready-Mixed Concrete
 17. ASTM C 114 Standard Test Method for Chemical Analysis of Hydraulic Cement
 18. ASTM C 136 Standard Method for Sieve Analysis of Fine and Coarse Aggregate
 19. ASTM C 138 Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
 20. ASTM C 143 Standard Test Method for Slump of Portland Cement Concrete
 21. ASTM C 150 Standard Specification for Portland Cement
 22. ASTM C 172 Standard Method of Sampling Fresh Concrete
 23. ASTM C 192 Standard Method of Making and Curing Concrete Test Specimens in the Laboratory
 24. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 25. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
 26. ASTM C 295 Standard Guide for Petrographic Examination of Aggregates for Concrete
 27. ASTM C 457 Standard Recommended Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete
 28. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
 29. ASTM C 595 Standard Specification for Blended Hydraulic Cements
 30. ASTM C 618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete

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|-----------------|---|
| 31. ASTM C 989 | Standard Specification for Slag Cement for Use in Concrete and Mortars |
| 32. ASTM C1077 | Recommended Practice for Labs Testing Concrete |
| 33. ASTM C 1567 | Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |

1.04 SUBMITTALS

A. Product Data

For each manufactured material and product utilized under this section including, but not limited to, aggregates, admixtures, method of adding admixtures, materials and method of curing, method of developing bond at joints, joint materials, waterstops, and vapor barriers.

B. Design Mixes

For each concrete mix indicated.

C. Shop Drawings

Include details of steel reinforcement placement including material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports. Shop drawings to include the proposed construction and control joint locations.

D. Material Certificates

E. Testing agency to perform service required in ACI 301.

F. Laboratory tests on concrete.

G. If ready-mixed concrete is used, provide the following:

1. Physical capacity of mixing plant.
2. Trucking facilities available.
3. Estimated average amount which can be produced and delivered to the site during a normal 8-hour day excluding the output to other customers.
4. Delivery Tickets and Batch Tickets: Furnish to Engineer copies of all delivery tickets and batch tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94.

H. Submit the following in accordance with Section 01330, Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.
2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.
3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.
4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, aggregate soundness tests, petrographic analysis, mortar bar expansion testing per ASTM C 1567, etc.
5. Manufacturer's data on all admixtures stating compliance with required standards.

6. Concrete mix design for each class of concrete specified herein.
7. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.
8. Testing procedures for structures to be leak tested.
9. Testing report upon completion of leak testing. Report shall include test summary, test data and calculations.

1.05 QUALITY ASSURANCE

- A. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.
- B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.
- C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a testing laboratory employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

PART 2 - PRODUCTS

2.01 HYDRAULIC CEMENT

- A. Portland Cement
 1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.02 or 2.03 respectively.
 2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:
 - a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.40%.
 - b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalies in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%.
 3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.
 4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement) or Type IS (Portland Slag Cement) conforming to ASTM C 595.
2. Type IP cement shall be an interground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.
3. Type IS cement shall be an interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.
4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.
5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalis in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.2.

C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

D. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.02 FLY ASH

- A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.
- B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.
- C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the provisions of Article 2.05.G.2.
- D. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.03 SLAG CEMENT

- A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.

- B. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the provisions of Article 2.05.G.2.
- C. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- D. Additional slag cement shall not be included in concrete mixed with type IS or IP cement.

2.04 WATER

- A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.
- B. Water shall not contain more than 100 PPM chloride.
- C. Water shall not contain more than 500 PPM dissolved solids.
- D. Water shall have a pH in the range of 4.5 to 8.5.

2.05 AGGREGATES

- A. All aggregates used in normal weight concrete shall conform to ASTM C 33.
- B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.
- C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.
- D. For Class A4 concrete, coarse aggregate shall be Size #8M in accordance with ASTM C33.
- E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using magnesium sulfate.
- G. Non-reactive aggregates shall meet the following requirements:
 - 1. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:
 - a. Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.
 - b. Chert or chalcedony, 3.0%, maximum.
 - c. Tridymite or cristobalite, 1.0%, maximum.
 - d. Opal, 0.5%, maximum.

- e. Natural volcanic glass in volcanic rocks, 3.0%, maximum.
- 2. Proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.
- H. All aggregates shall be considered reactive unless they meet the requirements above for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.
- I. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.06 ADMIXTURES

- A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall conform to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.
 - 1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are "Eucon Series" by the Euclid Chemical Company, "Pozzolith Series" by BASF, and "Plastocrete Series" by Sika Corporation.
 - 2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Rheobuild 1000 or Glenium Series" by BASF, and "Daracem 100 or Advaflo Series" by W.R. Grace.
 - 3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.
 - 4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more

than 0.05% chloride ions. Acceptable products are “Eucon NR or Eucon Retarder 100” by the Euclid Chemical Company, “Pozzolith Retarder” by BASF, and “Plastiment” by Sika Corporation.

- C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.
- D. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review by the Engineer.

2.07 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.
- B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.
 - 1. Compressive Strength (28 day)
 - a. Concrete Class A1, A2, A3,A4 4,500 psi (minimum)
6,500 psi (maximum)
 - b. Class B 3,000 psi (minimum)
 - c. Class C 2,000 psi (minimum)
 - 2. Maximum water/cementitious materials ratio, by weight
 - a. Concrete Class A1, A2, A3,A4 0.42
 - b. Class B 0.50
 - c. Class C 0.75
 - 3. Slump range
 - a. 4" nominal unless high range water reducing admixture is used.
 - b. 3" maximum before addition of high range water reducing admixture.
 - c. Except, 3-6" for Class C concrete
 - 4. Air Content
 - a. Concrete Class A1, A3,A4 6% ±1.5%
 - b. Class A2, B 3% Max
 - c. Class C N/A

2.08 FLOWABLE FILL

Flowable Fill is considered Class F concrete for filling spaces as permitted and direction by the Engineer. Flowable fill must have proportions by volume in agreement with the following table:

Concrete Class	F
28-day Compressive strength, psi Laboratory Trial Batch for Selecting Concrete Proportions, average 28-day	50-100
Compressive Strength, psi, design mix	N/A
Cement Content per cubic yard of concrete, sacks minimum/maximum **	0.4-3.0 12/16.0**
Water/Cement Ratio by weight, minimum/maximum	0.40/0.75
Air Content, percent by volume	NA
Slump at point of placement, inches	NA

** For concrete with fly ash, values are total of cement plus fly ash (Except Class F).

PART 3 - EXECUTION

3.01 TRIAL MIXES

- A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent testing laboratory designated by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.
- B. An independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. ___, Product ____." If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.02 PRODUCTION OF CONCRETE

- A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.
- B. Ready-Mixed Concrete
1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
 2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
 3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
 4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
 5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.
 6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:
 - a. Date and truck number
 - b. Ticket number
 - c. Mix designation of concrete
 - d. Cubic yards of concrete
 - e. Cement brand, type and weight in pounds
 - f. Weight in pounds of fine aggregate (sand)
 - g. Weight in pounds of coarse aggregate (stone)
 - h. Air entraining agent, brand, and weight in pounds and ounces
 - i. Other admixtures, brand, and weight in pounds and ounces
 - j. Water, in gallons, stored in attached tank
 - k. Water, in gallons, maximum that can be added without exceeding design water/cement ratio

- l. Water, in gallons, actually used (by truck driver)
 - m. Time of loading
 - n. Time of delivery to job (by truck driver)
7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.
 8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.
- C. Site Mixed Concrete
1. Scales for weighing concrete ingredients shall be accurate when in use within ± 0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
 2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:
 - a. Cement, fly ash, or slag cement ± 1 percent
 - b. Water ± 1 percent
 - c. Aggregates ± 2 percent
 - d. Admixtures ± 3 percent
 3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
 4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.
 5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.
 6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
 7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
 8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
 9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.
 10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.
13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.03 CONCRETE PLACEMENT

- A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.
- B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.
- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. This concrete shall be worked well into the irregularities of the hard surface.
- D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.
- E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cement ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.
- F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.

- G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise by Engineer.
- H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.
- I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.
- K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.
- L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.
- M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.
- N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.
- O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.
- P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators.

Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

- Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.
- R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.04 ORDER OF PLACING CONCRETE

- A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

3.05 CONCRETE WORK IN COLD WEATHER

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.
- B. In addition to the requirements of ACI 306, concrete placed at any time when air temperature is 40°F or lower shall have a minimum temperature, as placed, of 55°F for placements less than 12" thick, 50°F for placements 12" to 36" thick, and 45°F for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.
- C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of 100°F in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.06 CONCRETE WORK IN HOT WEATHER

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.
- B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand and in position prior to each placing operation.
- C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.
- D. The temperature of the concrete mix when placed shall not exceed 90°F.
- E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.
- F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.
- G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

3.07 QUALITY CONTROL

- A. Field Testing of Concrete
 - 1. The Contractor shall coordinate with the Owner's testing firm personnel as required for concrete testing.
 - 2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall provide assistance to the testing laboratory in obtaining samples. The Contractor shall dispose of and clean up all excess material.
 - 3. For every placement of concrete that is 10 cubic yards or less, the following tests shall be performed (as described in paragraphs B through E below):
 - a. Consistency
 - b. Unit Weight
 - c. Air content
 - d. Compressive Strength
 - e. Temperature

4. For every placement of concrete that is larger than 10 cubic yards, the following tests shall be performed for every 50 cubic yards (as described in paragraphs B through E below):
 - a. Consistency – test the first truck and one additional truck randomly selected by the Owner’s Resident Project Representative (RPR).
 - b. Unit Weight – test one truck randomly selected by the RPR
 - c. Air content - test the first truck and one additional truck randomly selected by the RPR.
 - d. Compressive Strength - test one truck randomly selected by the RPR
 - e. Temperature - test one truck randomly selected by the RPR

The sampling of concrete is approved at the truck discharge. If a concrete pump is employed, the Contractor is advised that 1.5-3.0% air is lost in pumping and such should be accounted for at the point of testing. Therefore, the air content should be adjusted to ensure that the air content meets the specification at the point of placement.

The first truck is defined as the first truck as accepted by the RPR. The RPR shall have the authority of the Owner to accept or reject all concrete.

5. Sampling is at the discretion of the RPR.
6. Additional testing may be required as deemed necessary by the Owner.

B. Consistency

1. The consistency of the concrete will be checked by the Owner’s testing firm by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Owner or Engineer may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.
2. Slump tests shall be made in accordance with ASTM C 143.
3. Concrete with a specified nominal slump shall be placed having a slump within 1” (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the Owner’s testing firm in accordance with ASTM C 138.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the Owner’s testing firm in accordance with ASTM C 231.
2. In the event test results are outside the limits specified, additional testing shall occur. Upon discovery of incorrect air entrainment, the concrete shall be removed from the jobsite.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the Owner’s testing firm and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.
2. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The Owner’s testing firm will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

3. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.
4. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.
5. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.
2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.
 - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.07).
 - b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.
 - c. No more than 10% of the compressive tests have strengths greater than the maximum strength specified.
3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.
5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:
 - a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
 - b. Maintain or add temporary structural support as required.
 - c. Correct the mix for the next concrete placement operation, if required to remedy the situation.
6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. Additional Tests

1. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.
 - a. Three cores shall be taken by the Owner's testing firm for each sample in which the strength requirements were not met.
 - b. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.
2. Concrete placed with compressive strengths greater than the maximum strength specified shall be removed and replaced or repaired as deemed necessary by the Engineer.

3.08 CARE AND REPAIR OF CONCRETE

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.
- B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed by the Engineer.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the Engineer. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the Engineer.
- D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed by the Engineer. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the Engineer. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the Engineer, unless other means of repair are deemed necessary and approved by the Engineer. Extensive repair or replacement will be considered for concrete placed having compressive strengths greater than maximum strength specified. All repair work shall be performed at no additional cost to the Owner.

- E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed by the Engineer as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be directed by the Engineer.

END OF SECTION

SECTION 03350 - CONCRETE FINISHES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330 - Submittals.
 - 1. Manufacturer's literature on all products specified herein.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

- A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.
 - 1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than 1/4-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than 1/4-inch in any dimension. Honeycombs shall be chipped back to solid

concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

- A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
 1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a stiff brush or rake prior to final set.
 2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.
 3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.
 4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.
6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.
7. Type "G" Hardened Finish: This finish shall be applied after completion of a Type "B" or Type "C" finish and prior to application of a Type "D" finish. Hardeners shall be applied in strict accordance with the manufacturer's requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type "D" finish shall be applied following completion of application of the hardener.
 - a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.².
 - b. Non-oxidizing heavy-duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.².
8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip shake-on aggregate concurrently with the application of a Type "D" finish. Application procedure shall be in accordance with manufacturer's instructions.
9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of $\pm 1/4$ inch.

3.03 FINISHES ON EQUIPMENT PADS

- A. Formed surfaces of equipment pads shall receive a Type III finish.
- B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Concrete surfaces indicated to receive textured	I
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 foot below water surface to bottom of wall	I
From top of wall to 1 foot below water surface	I
Exterior concrete walls below grade	I
Exterior exposed concrete walls grout cleaned smooth surface	II
Exterior exposed concrete ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	I
All interior exposed concrete walls and vertical surfaces	I
Interior exposed ceiling, including beams	III
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B
All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D
All interior finish floors of buildings and structures which are not continuously or intermittently wet	D
Floors to receive tile, resilient flooring, or carpeting	D
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E
Floors of process equipment tanks indicated on Drawings to receive grout topping	F
Garage and storage area floors	G
Precast concrete form panels, hollow core planks, double tees to receive concrete topping	J

END OF SECTION

SECTION 03370 - CONCRETE CURING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03300 - Cast-In-Place Concrete
- C. Section 03350 - Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. ACI 305 - Hot Weather Concreting
 - 4. ACI 306 - Cold Weather Concreting
 - 5. ACI 308 - Standard Practice for Curing Concrete
 - 6. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
 - 7. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. Federal Specification TT-C-800

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittals.
 - 1. Proposed procedures for protection of concrete under wet weather placement conditions.
 - 2. Proposed normal procedures for protection and curing of concrete.
 - 3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
 - 4. Proposed method of measuring concrete surface temperature changes.
 - 5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 - PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

- A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m² when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals, and Cure & Seal 30 Plus by Symons Corporation.
- B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurex DR VOX" or "Kurex W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

PART 3 - EXECUTION

3.01 PROTECTION AND CURING

- A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.
- C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.
- D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.
 - 1. Ponding or continuous fogging or sprinkling.
 - 2. Application of mats or fabric kept continuously wet.
 - 3. Continuous application of steam (under 150°F).
 - 4. Application of sheet materials conforming to ASTM C171.
 - 5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.
- E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.
- F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

- A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.
- B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.
- C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.
- D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.
- E. Protect concrete to provide continuous warm moist curing immediately after placement and during protection period. Minimum protection period is 7 days. Maintain these temperatures:
 - Concrete section <12" during protection period – 55 F
 - Concrete section 12" to 36" during protection period – 50 F
 - Concrete section 36" to 72" during protection period – 45 F

At the end of the protection period, allow concrete to cool gradually to the ambient temperature.

- 1. Where temperature of concrete exceeds ambient by 20 degrees Fahrenheit or more, loosen forms and leave in place for at least 24 to 48 hours before removal.
- 2. If water curing has been used, maintain concrete temperature for at least 24 hours after water curing is terminated. Allow water-cured concrete to air dry for 72 hrs. before exposure to freezing temperatures.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

- A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.
- B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.
- C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory

for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

- D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least four (4) additional days using one of the methods listed in paragraph 3.01D.
- E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

- A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.
- B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

- A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:
 - 1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.
 - 2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

END OF SECTION

SECTION 03930 - REPAIR OF EXISTING CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of repair of existing concrete structures shown on Drawings and specified, and includes patching loose, spalled, and unsound concrete, grouting cracks, removing debris resulting from Work, and other Work required to produce a neat and complete job.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 METHODS OF PAYMENT

- A. Repair over 2 inches Deep: Measure surface area and average depth after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the volume of each location for repair. These measurements shall be done to the nearest inch, and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown, will be included in a Change Order increasing or decreasing the Contract Price noted on Bid Form.
- B. Repair Equal to or Less than 2 Inches Deep: Work shall be paid for by the square foot of surface area repaired. Measure surface area after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the surface area of each location or fraction of each location for repair that is equal to or less than 2 inches deep. These measurements shall be done to the nearest 0.1 square foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.
- C. Pressure Injection of Epoxy Resin: Work will be paid for by the linear foot of crack injected. These measurements shall be done to the nearest linear foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.
- D. Pressure Injection of Hydrophilic Grout: Work will be paid for by the linear foot of crack injected. These measurements shall be done to the nearest linear foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for proprietary materials and items, including patching compounds and others requested by ENGINEER.
 - 2. Samples of materials as requested by ENGINEER, including names, sources, and descriptions.

- B. Material certificates in lieu of laboratory test reports on other materials. Manufacturer and CONTRACTOR shall sign material certificates certifying that each material item complies with, or exceeds, specified requirements.
- C. Qualification Data for Installers.
 - 1. Manufacturer's certificates that the installer's workers are trained and qualified for each type of product.
 - 2. Satisfactory experience record including references from previous applications of the specified materials for repairs of a similar type and under similar conditions.
- D. Repair Plan: Submit before Work begins.

1.04 REFERENCES

- A. Codes and Standards:
 - 1. Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - a. ACI 224, Causes, Evaluation, and Repair of Cracks.
 - b. ACI 201, Chapter 6, "Repair of Concrete."
 - c. ACI 301, Specifications for Structural Concrete for Buildings.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Each product manufacturer shall employ factory-trained technical representatives who are available for consultation and Project-site inspection and assistance at no additional cost.
- B. Installer Qualifications: Entity qualified in the field of concrete repair with a minimum of 5-years experience and employs installers and supervisors who are trained and approved by product manufacturers to apply products used.
- C. Repair Plan: Prepare a written plan for repair of cast-in-place concrete, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during Work. Describe in detail materials, methods, equipment, and sequence of operations to used for each phase of the Work.
- D. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at CONTRACTOR's expense.
- E. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at CONTRACTOR's expense.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

- B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
- C. Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, or freezing temperatures.

1.07 FIELD CONDITIONS

- A. Cold-Weather Requirements for Cementitious Materials: Do not apply unless concrete-surface and air temperatures are above 40-degrees F and will remain so for at least 48 hours after completion of Work.
- B. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures 90-degrees F and above.
- C. Protect adjacent finish materials against spatter during patching operations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- 1. Cement-Polymer Patching Mortar:
 - a. Trowel-Grade, Horizontal Surfaces:
 - 1) "EMACO R310 CI," BASF Construction Chemicals LLC.
 - 2) "Eucocrete Supreme" or "Thin-Top Supreme," Euclid Chemical Co.
 - 3) "SikaTop 122 Plus," Sika Chemical Corp.
 - b. Trowel-Grade, Vertical/Overhead Surfaces:
 - 1) "Gel Patch," BASF Construction Chemicals LLC.
 - 2) "Verticoat Supreme," Euclid Chemical Co.
 - 3) "SikaTop 123 Plus," Sika Chemical Corp.
 - c. Formed Surfaces:
 - 1) "EMACO S66 CI," BASF Construction Chemicals LLC.
 - 2) "Tamms Form and Pour," Euclid Chemical Co.
 - 3) "Sikacrete 211 SCC Plus," Sika Chemical Corp.
- 2. Epoxy Injection Resin:
 - a. "Concresive Standard LVI," BASF Construction Chemicals LLC.
 - b. "Prime Rez 1000 High Mod or 1100 High Mod LV," Prime Resins, Inc.
 - c. "Sikadur 35 Hi-Mod LV," Sika Chemical Corp.
- 3. Polyurethane Chemical Grout:
 - a. "Concresive 1210 IUG," BASF Construction Chemicals LLC.
 - b. "Hydro Active Sealfoam NF," De Neef Construction Chemicals, Inc.
 - c. "Prime Flex 900 XLV or 900 LVSF," Prime Resins, Inc.
 - d. "Sikafix HH Hydrophillic," Sika Chemical Corp.

2.02 PATCHING MATERIALS

- A. Patching up to 2-inch Deep: Cement-polymer patching mortar with an integral corrosion inhibitor suitable for the particular patching application.
- B. Patching over 2-inches Deep: Class A concrete with the use of an epoxy bonding agent applied at the bonding surfaces, unless otherwise noted.
- C. Epoxy Injection Resin: Moisture-insensitive 2-component epoxy-resin system conforming to ASTM Specification C 881, Type I. Provide Grade and Class to suit Project requirements.
- D. Grouting of Non-structural and Leaking Cracks: Moisture reactive (hydrophilic) TDI (toluene diisocyanate) based polyurethane chemical grout. For structures in contact with potable water, chemical grout shall be NSF 61 approved.

2.03 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

PART 3 - EXECUTION

3.01 GENERAL

- A. All workers shall have sufficient experience on concrete repair work to be familiar with the use of these materials and methods of operation.
- B. To ensure the quality of the finished work, ENGINEER may require CONTRACTOR to replace workers who, in his judgment, are not capable or qualified to perform this Work. CONTRACTOR, upon receipt of the written notification from ENGINEER, shall immediately comply with this request at no additional cost to OWNER.

3.02 PREPARATION

- A. Ensure that supervisory personnel are on-site and on duty when concrete repair work begins and during its progress.

3.03 PATCHING

- A. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries.
- B. Square cut perimeter of areas to be patched to a minimum depth of 1/4-inch. Remove deteriorated or unsound concrete as required to reach sound concrete. Removal shall be to a minimum depth of 1/4-inch.
- C. Thoroughly clean by sandblasting all corroded and rusted reinforcement. Wherever a reinforcing bar has lost more than 30 percent of its cross-sectional area, place a new bar of the same size parallel to it using 24-bar diameters lapped length at each end. When a bar has exposed 50 percent or more of

its perimeter, chip out the concrete around the bar to provide a minimum of 1-inch gap all around so the bar can be completely encased in new mortar.

- D. Test areas where concrete has been removed by tapping with a hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
- E. After concrete removal, mechanically prepare concrete surface to obtain a minimum surface profile of 1/16-inch +/-.
- F. Thoroughly clean dirt, oil, dust, or foreign matter from repair surfaces. Dampen concrete substrate to a saturated surface dry condition. Coat substrate with bonding agent.
- G. The patching material must be applied within the working time of the bonding agent. Use bonding agent only on surfaces not requiring formwork or when the patching material can be applied within manufacturer's recommended working time.
- H. Prepare the cement mortar per manufacturer's recommendations. Apply mortar with a spatula pressed tight against existing surfaces and filling all voids. Build up mortar to original lines in one or more layers, with each layer thickness not to exceed that recommended by the manufacturer, and finished smooth with a steel trowel.

3.04 PRESSURE INJECTION OF CRACKS

- A. Drilling Injection Holes :
 - 1. Pressure injection of epoxy resin: Drill holes into face of crack.
 - 2. Pressure injection of hydrophilic grout: Drill injection holes along the sides of the cracks set at an angle of 45-degrees from the surface of the concrete so the holes intersect the crack near the mid-section of the concrete. Alternate holes from one side of crack to the other.
 - 3. Minimum hole spacing should equal thickness of the concrete to be repaired.
- B. Flush drilling dust out of out of injection holes by use of water and a flushing wand that reaches the back of the hole. Install injection packers or ports in the injection holes. Mechanically clean and surface seal cracks wider than 1/8-inch with hydraulic cement or epoxy gel adhesive.
- C. Thoroughly flush cracks with potable water prior to grout injection.
- D. Inject chemical grout, maintaining slow, steady pressure until crack is filled. In slabs, injection shall start at the first packer or port that was flushed with water. In walls, injection shall start at the lowest packer or port. Move to next adjacent packer or port when the injection material appears from adjacent packers or ports. Reinject first packer or port after pumping a number of locations.
- E. Remove injection packers or ports and patch injection holes with patching mortar. Remove excess cured grout, hydraulic cement, or epoxy gel and clean surface.

3.05 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcing placement and supports.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond to patching material.
- C. Accurately position, support, and secure reinforcement against displacement by construction or patching operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.
- D. Place reinforcement to obtain minimum coverings for reinforcement protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during patching operations. Set wire ties to direct ends into concrete, not toward exposed surfaces.

3.06 SURFACE FINISHES

- A. Patching: Provide finish to match adjacent concrete surfaces unless otherwise noted.

3.07 CURING AND PROTECTION

- A. Protect freshly placed material from premature drying and excessive cold or hot temperatures.
- B. Patching up to 2 Inches Deep: Perform curing as recommended by patching mortar manufacturer.
- C. Patching over 2 Inches Deep: Perform curing of Class A concrete as specified in Section 03300.

3.08 REPAIR OF DEFECTS

- A. Repair patch areas that lack uniformity or have honeycomb, rock pockets, voids over 1/4-inch in diameter, and holes left by tie rods and bolts.

END OF SECTION

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous framing and supports for the following:
 - a. Grating support
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance: CONTRACTOR shall furnish services to design, engineer, fabricate, and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data for products used in miscellaneous metal fabrications, including paint products and grout.
 - 2. Shop Drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - a. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified Professional Engineer who was responsible for their preparation.
 - 3. Samples representative of materials and finished products as may be requested by ENGINEER.
 - 4. Welder certificates signed by CONTRACTOR certifying that welders comply with requirements specified under "Quality Assurance" paragraph.
 - 5. Qualification data for firms and persons specified in "Quality Assurance" paragraph to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Engineers and Owners, and other information specified.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firms experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1, "Structural Welding Code - Steel," D1.3, "Structural Welding Code - Sheet Steel," and D1.2, "Structural Welding Code - Aluminum."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Engineer Qualifications: Professional Engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.01 ALUMINUM

- A. Extruded Bars and Shapes: ASTM B 221, alloys as follows:
 - 1. 6061-T6 for bars and shapes.

2.02 FASTENERS

- A. All anchors, fasteners, and hardware shall be 304 stainless steel. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.
- C. Lag Bolts: Square head type, FS FF-B-561.
- D. Machine Screws: Cadmium-plated steel, FS FF-S-92.
- E. Wood Screws: Flat head carbon steel, FS FF-S-111.

- F. Plain Washers: Round, carbon steel, FS FF-W-92.
- G. Drilled-In Expansion Anchors: Expansion anchors complying with FS FF-S-325, Group VIII (anchors, expansion, [nondrilling]), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B-575, Grade 5.
- H. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class, and style as required.
- I. Lock Washers: Helical spring type carbon steel, FS FF-W-84.

2.03 FABRICATION

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on Shop Drawings using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 100 degrees F (55.5 degrees C).
- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.
 - 1. Remove sharp or rough areas on exposed traffic surfaces.
 - 2. Weld corners and seams continuously to comply with AWS recommendations and the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
 - 3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
 - 4. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- F. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- G. Cut, reinforce, drill, and tap miscellaneous metal Work as indicated to receive finish hardware, screws, and similar items.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.04 ROUGH HARDWARE

- A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6.
- B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Provide framing and supports for applications indicated or which are not a part of structural steel framework as required to complete work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from aluminum shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

2.06 FINISHES

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish metal fabrications after assembly.

2.07 ALUMINUM FINISHES

- A. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
- B. As Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer Qualifications: Arrange for installation of metal fabrications specified in this Section by same firm that fabricated them.

3.02 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 Site.

3.03 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
 - 1. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint or zinc chromate primer.

END OF SECTION

SECTION 06610 - FRP FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. FRP gratings
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Pultrusion: Process of pulling fiberglass rovings (strands), mats, and other forms of reinforcements such as woven fiberglass through baths of thermosetting liquid resin, and then through a heated forming die (made of steel) to form a completed composite fiberglass structural shape.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance: CONTRACTOR shall provide services to design, engineer, fabricate, and install the following FRP fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each FRP fabrication. Limit deflection to $L/200$.
- B. FRP Gratings: Capable of withstanding a uniform load of 200 pounds-force per square foot or a concentrated load of 300 pounds-force on an area of 4 square inches located in the center of the tread, whichever produces the greater stress.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings detailing fabrication and erection of each FRP fabrication indicated. Include plans, elevations, sections, and details of FRP fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - 2. Product Data for products used in miscellaneous FRP fabrications including paint products and grout.
 - 3. Where installed FRP fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified Professional Engineer responsible for their preparation.
 - 4. Samples representative of materials and finished products as may be requested by ENGINEER.
- B. Quality Control Submittals: Qualification data for firms and persons specified in "Quality Assurance" Paragraph to demonstrate their capabilities and experience. Include list of completed

projects with project name, addresses, names of Architects, Engineers and Owners, and other information specified.

1.05 QUALITY ASSURANCE:

- A. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in Work.
 - 1. Arrange for installation of FRP fabrications specified in this Section by same firm that fabricated them.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. FRP Gratings:
 - a. Fibergrate Corp.
 - b. Fowler Fiberglass Grating, Inc.
 - c. IKG Industries.
 - d. IMCO Reinforced Plastics, Inc.
 - e. International Grating, Inc.
 - f. Strongwell Corp.

2.02 FRP SURFACES

- A. For FRP fabrications exposed to view upon completion of Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for FRP sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

2.03 MATERIALS

- A. Fiberglass sheet or solid fiberglass bar shall be used to fabricate the internal connectors for the square tube. The internal connectors will be 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm) with length and angularity variable to meet the requirements of each connection. Angular connections shall be fabricated from fiberglass sheet bonded together using a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent to give a minimum thickness of 1-1/2 inches. The angular connections will be fabricated to the proper dimension from the fiberglass sheets that have been bonded together. Fiberglass sheet used for angular connections shall meet the properties specified in Table 1. Fiberglass solid bar, 1-1/2 by 1-1/2-inch, shall be used for the straight connections, and shall meet the properties specified in Table 1.
- B. Rivets shall be nickel copper or nonmetallic.
- C. Bolts shall be 3/8-inch (9.5 mm) diameter, 316 stainless steel.

- D. Adhesive used to bond internal connectors to fiberglass pultruded square tube shall be a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent.

2.04 FRP GRATINGS

- A. Glass fiber gratings shall be standard square mesh type or pultruded bar type manufactured of continuous glass fibers completely wetted with polyester resin.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate and provide anchorages, setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.

3.02 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. All cut edges and holes shall be sealed with a compatible resin system containing an UV inhibitor.

3.03 INSTALLATION OF FRP BAR GRATINGS

- A. Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and/or bar sizes indicated, including installation clearances and standard anchoring details.

END OF SECTION

SECTION 07900 - JOINT SEALERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of each form and type of joint sealer as indicated on Drawings and Schedules.
- B. Section includes joint sealers for the following locations:
 - 1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below.
 - a. Control and expansion joints in cast-in-place concrete.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated.
 - 2. Exterior joints in horizontal traffic surfaces as indicated below.
 - a. Control, expansion, and isolation joints in cast-in-place concrete slabs for floors and paving.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated.
 - 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces as indicated below.
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Joints between different materials listed above.
 - d. Other joints as indicated.
 - 4. Interior joints in horizontal traffic surfaces as indicated below.
 - a. Control and expansion joints in cast-in-place concrete slabs.
 - b. Other joints as indicated.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SYSTEM PERFORMANCE

- A. Provide joints sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data from manufacturer for each joint sealer product required, including instructions for joint preparation and joint sealer application.
 - 2. Samples for Initial Selection Purposes: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available for each product exposed to view.
 - 3. Samples for verification purposes of each type and color of joint sealer required. Install joint sealer samples in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealers.

4. Certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.05 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:
 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 degrees F (4.4 degrees C).
 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by joint sealer manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.06 SEQUENCING AND SCHEDULING

- A. Sequence installation of joint sealers to occur not less than 21 or more than 30 days after completion of waterproofing, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Multi-Part Nonsag Urethane Sealant for Use NT:
 - a. "Dymeric 240," Tremco, Inc.
 - b. "Dynatrol II," Pecora Corp.
 - c. "Sikaflex 2c NS", Sika Corp.
 2. One-Part Nonsag Urethane for Use NT:
 - a. "Dymonic," Tremco, Inc.
 - b. "Dynatrol I-XL," Pecora Corp.
 - c. "Sikaflex-15LM," Sika Corp.
 3. One-Part Nonsag Urethane Sealant for Use T:
 - a. "Sonolastic NP 1," BASF Building Systems.
 - b. "Sikaflex-1a," Sika Corp.
 - c. "Vulkem 45 SSL," Tremco Sealant/Weatherproofing Division, RPM.

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4. One-Part Pourable Urethane Sealant for Use T:
 - a. "Chem-Calk 950," Bostik Construction Products Division.
 - b. "Urexpan NR-201," Pecora Corp.
 - c. "Sikaflex-1CSL," Sika Corp.
 - d. "Vulkem 45," Tremco Sealant/Weatherproofing Division, RPM.
5. Multi-part Nonsag Immersible Polysulfide or Polyurethane Sealant:
 - a. "Synthacalk GC-2+," Pecora Corp.
 - b. "Sonolastic Polysulfide Sealant," Sonneborn, Degussa Building Systems.
 - c. "Vulkem 116," Tremco Sealant/Weatherproofing Division, RPM.
6. Pre-formed Foam Sealant:
 - a. Horizontal and Traffic Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal EPS," Will-Seal Construction Foams Dw., Illbruck.
 - b. Vertical Applications Above Grade (Control and Expansion Joints):
 - 1) "Emseal Greyflex," Emseal Corp.
 - 2) "Polytite Standard," Sandell Manufacturing Co., Inc.
 - 3) "Will-Seal 150," Will-Seal Construction Foams Dw., Illbruck.
 - c. Below Grade Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal 250," Will-Seal Construction Forms Dw., Illbruck.
 - d. Pre-formed Hollow Neoprene Gasket:
 - 1) The D.S. Brown Co.
 - 2) Watson-Bowman and Acme Corp.
 - 3) Williams Products, Inc.
7. Foamed-In-Place Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Pensil 851," General Electric Co.
8. One-Part Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Fyre Putty," Standard Oil Engineered Materials Co.
 - c. "Metachaulk 1100," The RectorSeal Corporation.
 - d. "RTV 7403," General Electric Co.
 - e. "3M Fire Barrier Caulk CP-25," Electrical Products Division/3M.
9. Joint Sealant Backing:
 - a. Expand-o-Foam, 1380 Series, Williams Products, Inc.
10. Joint Fillers for Concrete:
 - a. Cementone, W.R. Meadows.
 - b. Concrete Grey Sponge Rubber, 1300 Series, Williams Products, Inc.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealers, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application as demonstrated by sealant manufacturer based on testing and field experience.

2.03 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those referenced for type, grade, class, and uses.

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Abbreviations

Types, Grade, Uses (Exposure)

S	Single component	Type
M	Multi-component	Type
P	Pourable	Grade
NS	Nonsag	Grade
NT	Nontraffic	Use
T	Traffic	Use
I	Immersion	Use

Uses (Joint Substrates)

A	Aluminum
O	Other
G	Glass
M	Mortar

Class

25 - Percent Movement capability

- B. Multi-Part Nonsag Urethane Sealant for Use NT: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
1. Uses NT, M, A, and, as applicable to joint substrates indicated, O.
 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors. Provide a minimum of 30 colors for selection.
- C. One-Part Nonsag Urethane Sealant for Use NT: Type S, Grade NS, Class 25, and Uses NT, M, A, and, as applicable to joint substrates indicated, O.
1. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors. Provide a minimum of 7 colors for selection.
- D. One-Part Nonsag Urethane Sealant for Use T: Type S, Grade NS, Class 25, and complying with the following requirements for Uses:
1. Uses T, NT, M, G, A, and, as applicable to joint substrates indicated, O.
 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors. Provide a minimum of 3 colors for selection.
- E. One-Part Pourable Urethane Sealant for Use T: Type S, Grade P, Class 25, and complying with the following requirements for Uses:
1. Uses T, M, A, and, as applicable to joint substrates indicated, O.

2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors. Provide a minimum of 3 colors for selection.
- F. Multi-Part Nonsag Polysulfide or Polyurethane Sealant for Uses T, NT, I: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
1. Uses T, NT, I, M, G, A, and, as applicable to joint substrates indicated, O.
 2. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors.

2.04 COMPRESSION SEALS

- A. Pre-formed Foam Sealant: Manufacturer's standard pre-formed, pre-compressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellant agent; factory-produced in pre-compressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer; and complying with the following requirements:
1. Properties: Permanently elastic, mildew-resistant, nonmigratory, nonstaining, compatible with joint substrates and other joint sealers.
 2. Impregnating Agent:
 - a. Chemically stabilized acrylic (EMSEAL).
 - b. Neoprene rubber suspended in chlorinated hydrocarbons (WILL-SEAL).
 - c. Polymerized polybutylene (POLYTITE).
 3. Density: 8 - 10 pounds per cubic foot.
 4. Backing: None..
- B. Pre-formed Hollow Neoprene Gasket: Manufacturer's standard pre-formed polychloroprene elastomeric joint seal of the open-cell compression type complying with ASTM D 2628 and with requirements indicated for size, profile, and cross-sectional design.

2.05 JOINT SEALANT BACKING

- A. Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers: Pre-formed, compressible, resilient, nonwaxing, nonextruding strips of flexible, nongassing plastic foam of material indicated below; nonabsorbent to water and gas; and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Either open-cell polyurethane foam or closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer, for cold-applied sealants only.
- D. Elastomeric Tubing Joint Fillers: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -26 degrees F (-15 degrees C). Provide products with low compression set and of size and shape to provide a secondary seal, control sealant depth, and otherwise contribute to optimum sealant performance.

- E. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

- A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealer substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Provide nonstaining, chemical cleaners of type which are acceptable to manufacturer of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, do not leave oily residues, or otherwise have a detrimental effect on sealant adhesion or in-service performance.
- C. Masking Tape: Provide nonstaining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

2.07 JOINT FILLERS FOR CONCRETE

- A. Provide joint fillers of thickness and widths indicated.

Sponge Rubber Joint Filler: Pre-formed strips complying with ASTM D 1752 for Type I.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer Qualifications: Engage an installer who has successfully completed, within the last 3 years, at least 3 joint sealer applications similar in type and size to that of this Project.

3.02 EXAMINATION

- A. Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

3.03 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:
 - 1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealers, oil, grease, waterproofing, water repellants, water, surface dirt, and frost.
 - 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these

methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove laitance and form release agents from concrete.
 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on pre-construction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.04 INSTALLATION OF JOINT SEALERS

- A. Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.
 2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.
 3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.
 4. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.
 - a. Note: Install all sealant in interior joints after painting of adjoining surfaces have been performed. Do not paint over sealant joints.
- D. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 6A in ASTM C 962 unless otherwise indicated.
 2. Provide flush joint configuration per Figure 6B in ASTM C 962 where indicated.
 3. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 4. Provide recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated.
- E. Installation of Pre-formed Foam Sealants: Install each length of sealant immediately after removing protective wrappings, taking care not to pull or stretch material, and complying with sealant manufacturer's directions for installation methods, materials, and tools which produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.
- F. Installation of Pre-formed Hollow Neoprene Gaskets: Install gaskets, with minimum number of end joints, in joint recesses with edges free of spalls and sides straight and parallel, both within tolerances specified by gasket manufacturer. Apply manufacturer's recommended adhesive to joint substrates immediately prior to installing gaskets. For straight sections, provide gaskets in continuous lengths; where changes in direction occur, adhesively splice gaskets together to provide watertight joint. Recess gasket below adjoining joint surfaces by 1/8 to 1/4 inch.

3.05 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as Work progresses, by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.06 PROTECTION

- A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original Work.

END OF SECTION

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- C. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- D. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- E. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.
- F. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by CONTRACTOR prior to any storage or installation.
- G. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.
- H. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.
- I. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- J. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
 - 1. No Factory Finish: Surface preparation, priming, and finish painting.
 - 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 - 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 - 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
 - 5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
 - 6. Overhead sectional doors with a factory finish shall be field-painted on both interior and exterior exposed surfaces.

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- K. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- L. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
 - 1. Exterior exposed concrete surfaces and exposed concrete surfaces below the ground floor plan.
 - 2. Nonferrous metals and stainless steel, except copper and brass.
 - 3. Exterior aluminum siding.
 - 4. Nonexposed surfaces of treated lumber.
 - 5. Conduits below the main floor, except in rooms that are painted.
 - 6. Exterior gratings with a hot-dipped galvanized finish.
 - 7. Manufacturer's name and identification plates.
 - 8. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by ENGINEER.

1.02 DEFINITIONS

- A. Potable Water Use Defined: Paint or coatings in contact with water anywhere within the potable water system (including intake/treatment/storage/distribution), shall be tested and certified by the National Sanitation Foundation (NSF) or Underwriter's Laboratory (UL) as a protective (barrier) material as per ANSI/NSF Standard 61 (Listed Drinking Water System Components - Health Effects).

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Listing of all materials proposed for use on Work, including designation of the area, primer required, or purpose.
 - 2. Specification data sheets included for each specific material proposed.
 - 3. Application instructions included for each specific material proposed.
 - 4. Color samples.
- B. Furnish ENGINEER, for approval, a schedule for all painting as called for on Painting Schedule and Piping Color Code and Identification subsection.
- C. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.
- B. CONTRACTOR's Responsibility: It shall be CONTRACTOR's responsibility to check the compatibility of painting materials proposed for this Contract. CONTRACTOR shall coordinate this Work with other trades to ensure compliance with these Specifications.
- C. Acceptability of materials and performance shall be determined by ENGINEER.

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- D. Testing or certification may be required to aid ENGINEER's determination of fitness.
 - 1. Expense of testing and certification when required and, unless noted otherwise in the Contract Documents, shall be borne by CONTRACTOR.
 - 2. If destructive testing is required, CONTRACTOR shall repair damaged area. Expense of repair shall be borne by CONTRACTOR.
- E. Request, in writing, a review of each coat by ENGINEER of first finished surface of each type of color, texture, and workmanship. First acceptance of each type and color shall be visibly labeled by ENGINEER with removable labels as Project standard for that type and color of item. Labels shall remain in place until Work is finished.
 - 1. For spray application, paint a surface of 100-square-foot as Project standard.
 - 2. For roller application, apply a 36-square-foot mock-up as Project standard.
- F. All Work may be inspected as to proper surface preparation, pre-treatment, priming, dry film thickness, curing, color, and workmanship. CONTRACTOR shall supply the following applicable standards, test methods, and inspection equipment:
 - 1. SSPC-VIS-1 photographic blast cleaning standards.
 - 2. Inspectors wet film gauge.
 - 3. Inspectors magnetic dry film thickness gauge.
 - 4. Tinkor Razor M-1 low voltage Holiday Detector.
 - 5. Marke 5 Tooke Gauge.

1.05 FIELD PAINTING SUBMITTAL SCHEDULE

- A. Furnish ENGINEER, for approval, prior to commencing any painting, a Schedule similar to that below:

FIELD PAINTING SUBMITTAL SCHEDULE

<u>Item and/or Location</u>	<u>Type Material</u>	<u>Coverage per Coat</u>	<u>Paint Manufacturer</u>
Pre-treatment			
Primers			
Barrier coats			
Sealers			
Filler and leveling coats			
Existing paint, water-base epoxy coated			
Interior concrete floors and walkways, nonslip epoxy coated			
Interior concrete bases, curbs and platforms, epoxy coated			
Interior concrete, epoxy coated			
Interior concrete, latex coated			
Interior concrete block, epoxy coated			
Interior concrete block, latex coated			
Exterior concrete block, stained			
Exterior concrete block, elastomeric coated			
Interior nonsubmerged metal, epoxy coated			
Interior nonsubmerged metal, alkyd coated			
Exterior nonsubmerged metal, polyurethane coated			
Nonpotable submerged and intermittently submerged metal, coal-tar epoxy coated			
Potable submerged and intermittently submerged metal, epoxy coated			
Interior wood, alkyd coated			
Interior wood, stained			
Exterior wood, stained			
Exterior wood, latex coated			
Exterior PVC, vinylester, fiberglass, polyurethane coated			
Interior PVC, vinylester, fiberglass, epoxy coated			
Insulated piping, latex coated			
Interior plaster and drywall, latex coated			
Interior plaster and drywall, epoxy coated			
Exterior plaster, latex coated.			
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1.06 PROJECT MEETING

- A. Prior to ordering any materials under this Section, CONTRACTOR, ENGINEER, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting to review Work to be performed under this Section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in manufacturer's original, unopened packages and containers, bearing manufacturer's name and label and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Federal Specification number, if applicable.
 - 4. Manufacturer's stock number and date of manufacture.
 - 5. Contents by volume for pigment and vehicle constituents.
 - 6. Thinning instructions.
 - 7. Application instructions.
 - 8. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.08 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).
- C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Painting Materials:
 - a. ICI/Devoe Coatings, Louisville, KY.

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- b. Carboline Co., St. Louis, MO 63144.
 - c. PPG Industries, Pittsburgh, PA 15222.
 - d. Porter International, Louisville, KY 40203.
 - e. Sherwin-Williams Company, Cleveland, OH 44101.
 - f. Tnemec, North Kansas City, MO 64141.
2. Dry Film Thickness Gauge:
- a. Elcometer.
 - b. Nordstrom.

2.02 MATERIALS

- A. Painting materials shall be those as herein specified under "Field Painting Systems" Article.
- B. The specification designations, manufacturers and/or trade names herein are intended to establish a quality and standard for the materials used.
- C. Colors and sheen, where not specified, shall be selected by ENGINEER.
- D. Oil, turpentine, and other thinners used in the finishing Work shall meet the requirements of the latest appropriate ASTM.

2.03 FIELD PAINTING SYSTEMS

- A. The following systems may vary from the coverages and mil thickness shown if recommended by paint manufacturer and approved in writing by ENGINEER. Number of coats shall be as required to obtain the mil thickness specified.
- B. If no pre-treatment is required by paint manufacturer, the surfaces shall be solvent cleaned (SSPC-SP1); otherwise the surfaces shall be pre-treated as follows:
 - 1. Nonsubmerged Galvanized Metal: Apply 1 brush coat of phosphoric acid.
 - 2. Nonferrous Metals: Apply 1 coat of a 2-component wash primer formulated with a zinc chromate pigmented polyvinyl butyral resin and phosphoric acid at a minimum of 0.3 dry mils and maximum of 0.5 dry mils thickness.
- C. Field Priming and Sealing:
 - 1. Concrete and Concrete Block Primer and Sealer: Apply 1 coat of an approved material.
 - 2. Metal Primer: Apply 1 coat of a universal rust-inhibitive primer which can be used on both submerged and nonsubmerged ferrous metal and has the ability to accept alkyds, epoxy, vinyl, coal tar, chlorinated rubber, emulsion, coal-tar epoxies, epoxy ester, asphalt, and phenolic paints as finish coats. Apply at the rate of 1.5 dry mils or as recommended by manufacturer.
 - 3. Nonsubmerged Galvanized Metal Primer: If the finish paint required is self-priming, no primer is required. Otherwise, apply 1 coat of approved galvanized iron primer that will form a permanent bond coat for the finish coat.
 - 4. Sealant for Bituminous Coated Surfaces: Apply 2.5 dry mils of synthetic alcohol-soluble resin and titanium pigment, or as recommended by manufacturer in writing and approved by ENGINEER.
 - 5. Exterior Wood Primer: Apply 2.0 to 3.5 dry mils of an alkyd-linseed oil mildew-resistant film.
 - 6. Interior Wood Primer: Apply 2.0 to 3.5 dry mils of an oil alkyd undercoater to wood that has a painted finish called for.

D. Finish Paints:

1. Existing Painted Walls, Water-Base Acrylic Epoxy Coated: Apply 2 coats of a water-base acrylic epoxy at 2.0 to 2.5 mils per coat.
2. Interior Concrete Floors, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils minimum per coat. The second coat shall provide a nonslip surface.
3. Interior Concrete, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils minimum per coat.
4. Interior Concrete Curbs and Platforms: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils minimum per coat.
5. Interior Concrete where Hydrostatic Back-pressure is Determined, Latex Coated: Apply 2 coats of an acrylic latex finish at 2.0 to 3.0 dry mil minimum per coat.
6. Exterior Nonsubmerged Poured Concrete, Modified Epoxy Masonry Texture Coating: Apply 1 coat of a modified epoxy masonry texture coating at coverage of 70 to 90 square feet per gallon. Backroll to assure proper penetration into concrete.
7. Interior Concrete Block, Latex Coated: Apply an acrylic emulsion sealer or leveler coat and 2 coats of an acrylic latex finish at 2.0 to 3.0 dry mils per coat.
8. Interior Concrete Block, Epoxy Coated: Apply a modified epoxy sealer at the rate of 60 to 80 square feet per gallon, and 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils per coat.
9. Exterior Concrete Block, Elastomeric Coated: See Section 09672.
10. Exterior Concrete Block, Stained: See Section 07145.
11. Interior Nonsubmerged Metal: In rooms and areas that have the walls finished with latex or alkyd paint, apply 2 coats of a medium to long alkyd resin finish at 2.0 to 3.5 dry mils per coat. All other items of interior nonsubmerged metal that are specified to be painted shall be finished by applying 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.
12. Exterior Nonsubmerged Metal, Polyurethane Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils, and 1 final coat of an aliphatic polyurethane enamel at 2.0 to 3.0 dry mils. The second coat shall have a color close to the final finish.
13. Non-Potable Submerged and Intermittently Submerged Metal, Coal-tar Epoxy Coated: Apply 2 coats of a coal-tar epoxy finish at 8.0 to 10.0 dry mils per coat.
 - a. Spray application is necessary to obtain required film thickness. Spray application shall be made in crosshatches to achieve required dry film thickness. Brush or roller application will require additional coats to obtain the required film thickness at no additional expense to OWNER. Additional coats to meet the dry film thickness requirements must be applied within 24 hours of application of first coat of coal-tar epoxy. CONTRACTOR shall provide adequate protection of adjacent areas to protect against overspray.
14. Potable Submerged and Intermittently Submerged Metal, Epoxy Coated: Apply 2 coats of an epoxy-polyamide or epoxy-polyamine system as approved by the NSF for potable water service conforming to AWWA D102 inside System No. 1.
15. Interior Wood, Alkyd Coated: Apply 2 coats of an alkyd resin finish at 2.0 to 3.0 dry mils per coat.
16. Interior Wood, Stained: Apply 1 coat of pigmented stain and 3 coats of varnish.
17. Exterior Wood, Stained: Apply 2 coats of pigmented stain.
18. Exterior Wood and Interior Fire-Protected Wood Latex Coated: Apply 2 coats of an acrylic latex finish at 2.0 dry mils minimum.
19. Exterior PVC, Vinylester, or Epoxy Resin Fiberglass: These nonsubmerged materials shall be painted the same system as for exterior nonsubmerged metal. Submerged and intermittently submerged materials shall be painted the same system as for submerged and intermittently submerged metal.

20. Interior PVC, Vinylester, or Epoxy Resin Fiberglass, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.
21. Insulated Piping, Acrylic Coated: Apply 2 coats of an acrylic enamel at 2.0 to 2.5 dry mils per coat.
22. Interior Plaster and Drywall, Latex Coated: Apply 1 coat of latex primer at 1.5 dry mils minimum, and 2 coats of an acrylic latex finish at 1.0 to 1.5 dry mils.
23. Interior Plaster and Drywall, Epoxy Coated: Apply 1 coat of latex primer at 1.5 dry mils, and 2 coats of polyamide-cured epoxy finish at 2.0 to 2.5 dry mils per coat.
24. Exterior Plaster, Latex Coated: Apply 1 coat of a modified epoxy masonry texture coating at the rate of 80-100 square feet per gallon, and 1 coat of an acrylic latex finish at 2.0 to 3.0 dry mils.

2.04 PIPING COLOR CODE AND IDENTIFICATION

- A. CONTRACTOR shall furnish ENGINEER for approval, prior to commencing any painting, a Schedule showing colors and markings proposed.
- B. The pipe color code and identification nomenclature shall be as designated on the Piping Color Schedule. CONTRACTOR shall contact ENGINEER for an approved color and appropriate name if no designation is Scheduled.
- C. Pipe markings and banding shall be placed on exposed pipe by stenciling or other method as approved by ENGINEER. The markings shall include an appropriate name and direction of flow arrow. The markings shall be located at intervals not to exceed 15 feet and shall occur at least once in every room unless otherwise approved by ENGINEER. Letters and arrows shall be white-on-dark colored surfaces and black-on-light colored surfaces, shall be proportioned to the size of the pipe, and shall be located in an area that will facilitate readings.

Size of Identification Letters	
Outside Diameter of Pipe or Covering (inches)	Size of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
over 10	3-1/2

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. Workmanship shall be of the best grade with materials evenly spread and smoothly flowed on, without runs or sagging of materials. No adulterations or changes of proportions shall be permitted unless recommended by manufacturer and approved by ENGINEER. Paint shall be applied in strict conformity with the manufacturer's directions.

3.02 EXAMINATION

- A. It is the responsibility of the painter to thoroughly inspect all surfaces prior to the commencement of Work to determine if the Work is ready to be prepared and painted.
- B. Report in writing to ENGINEER, all conditions that may potentially affect the application.
- C. Do not commence until such defects have been corrected.
- D. Start of painting shall be construed as the applicator's acceptance of surfaces and conditions within a particular area.

3.03 PREPARATION

- A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in places that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, removed items shall be reinstalled by workers skilled in the trades involved.
 - 1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- B. Surface Preparation: Prior to applying specific finishes, exposed surfaces requiring field painting shall be properly filled, scraped, sanded, etched, brushed, and/or cleaned as required to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease.
 - 1. Surfaces shall be prepared in accordance with manufacturer's recommendations. Surfaces shall be inspected and accepted by CONTRACTOR before coatings are applied.
 - 2. No change in treatment of surfaces shall be permitted unless recommended by manufacturer and approved by ENGINEER.
- C. Cementitious Materials Preparation: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforcement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen, as required, to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - 1. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
 - 2. Cementitious Work shall be cured at least 28 days before painting.
 - 3. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
 - 4. Hidden dampness (moisture content) shall be checked by using a polyethylene cover test. A heavy gauge plastic film, approximately 18 inches square and 4 mils thick, is securely taped to a small section of the concrete. Pieces of test film should be placed at various locations not exposed to direct sunlight that are likely to be slow drying, such as below grade, low spots in floors, inside corners, and lower wall areas. The polyethylene sheet is checked after 24 hours for beads of moisture. If condensation appears on the back side of the film, or if the concrete under the film appears to be darker, damp or wet, this indicates the presence of moisture in the concrete. Painting shall not be performed until no condensation exists after the 24-hour test period.

5. Steel troweled surfaces shall be acid etched to a "fine sandpaper" finish with a muriatic solution of approximately 10 to 15 percent. Flush the floor with clean water to remove acids, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
 6. Surfaces formed by smooth formwork shall be whipped (brush-off) sandblasted to remove all slag, laitance, form release agents, rough edges, and open air holes. All bug holes shall be filled with non-shrink, nonmetallic grout.
- D. Metals Preparation: Submerged ferrous metals shall have all welds ground smooth to remove spatter, recesses, pinholes, and protrusions. Metal shall be degreased in accordance with SSPC-SP1 and abrasive blast cleaned in accordance with SSPC-SP10, "Near White Abrasive Blast Cleaning."
1. Nonsubmerged ferrous metals shall be degreased in accordance with SSPC-SP1 and sandblasted in accordance with SSPC-SP6, "Commercial Abrasive Blast Cleaning."
 2. Nonferrous and galvanized metals shall be degreased in accordance with SSPC-SP1.
 3. Submerged galvanized metals shall not be treated.
 4. Steel surfaces that are to be repainted shall be commercial blast cleaned in accordance with SSPC-SP6 until at least 2/3 of each element is free of all visible residues.
- E. Wood Preparation: Wood surfaces to be finished shall be clean, dry, smooth, warm, and in proper condition to receive the finish. Remove surface deposits of sap or pitch by scraping and wiping clean with mineral spirits. Spot coat knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after the primer has dried and sand between coats. Back-prime interior and exterior woodwork.
- F. PVC and FRP Preparation: No special surface treatment is required. Surface shall be clean and dry.
- G. Drywall Construction: Joint compound material shall be sanded to provide a smooth flat surface. Remove dust from surface by wiping with clean rags or other means.

3.04 PRE-TREATMENT OF METAL

- A. Nonsubmerged galvanized metal and nonferrous metal shall be pre-treated. The galvanized pre-treatment shall be allowed 30 minutes for reaction to take place, then the residue shall be removed with a water rinse.

3.05 FIELD PRIMING AND SEALING

- A. In general, metal surfaces requiring field painting shall receive a priming coat before shipment from the shop. Such priming coats shall be compatible to subsequent applied coats.
1. Wherever Work requiring field painting bears no priming coat, or has a damaged shop coat, it shall have the surface prepared as specified and shall receive an approved priming coat, applied before and in addition to the finish coats required.
 2. Concrete surfaces, requiring field painting, shall be primed and sealed if recommended by the manufacturer of the finish paint.

3.06 PAINT MATERIALS PREPARATION

- A. Carefully mix and prepare paint materials in accordance with manufacturer's directions.
1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.07 TINTING

- A. Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.08 APPLICATION

- A. First Field Coat: The first field coat shall be the best suited for use with the surfaces to be covered and with the final coats. Whenever the finish color permits, the first coat shall be slightly tinted to the end that complete coverage of the final coat may be assured.
- B. Finish Coats: Apply in a uniform manner and of the mil thicknesses as specified. Where the mil thickness recommended by manufacturer is in conflict with that thickness specified, the proposed thickness shall be submitted in writing by manufacturer, supported by evaluative data sheets, subject to approval by ENGINEER. Where the mil thickness is omitted, it shall be as recommended by the manufacturer to give an excellent surface finish. Finished surface thickness shall be subject to spot checking by ENGINEER using a wet and/or dry gauge. Deficiencies in required thickness shall be corrected by addition of extra coats at no additional cost to OWNER.
- C. Thinners: Those recommended by manufacturer shall be used and the amounts shall not exceed recommendations by manufacturer.
- D. Caution: Paints shall not be applied on damp surfaces or on preceding coats not thoroughly dried, and shall not be applied on outside surfaces in extreme cold, frosty, foggy, or damp weather unless permitted by the materials manufacturer in the standard application specification. Materials shall not be applied when the temperature is below 50 degrees F. Drying time between coats shall be as recommended by paint manufacturer.
- E. Spraying: Spraying will be permitted only for such Work as approved by ENGINEER.
 1. Spraying equipment shall be of a type and capacity adapted to Work and shall be subject to ENGINEER's approval. Spraying equipment, including temporary rigid piping, flexible hose, nozzles, etc., shall be kept in such condition as will ensure against breakdowns and stoppage.
 2. Particular care shall be exercised to prevent the soiling or damaging of adjacent Work. Brushing shall immediately follow the spraying when necessary to eliminate wrinkling, blistering, and air holes.
- F. Painting Existing Surfaces: Repainted existing surfaces shall receive a finish to match the existing Work. Where the existing surfaces are irregular, they shall be made smooth with an approved leveler coat.

3.09 PROTECTION, SPECIAL PRECAUTIONS, AND CLEAN UP

- A. Reasonable care shall be used to prevent splattering. Drop cloths and masking materials shall be used to protect surfaces and parts of equipment that are not required to be painted under the Contract. Splashes, drippings, and stains shall be thoroughly removed upon the completion of Work.
- B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their Work after completion of painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- C. Lighting fixtures shall be covered and protected, or removed and replaced upon completion of Work. Electric switch plates, surface hardware, and similar equipment shall be removed, protected and replaced.
- D. Materials shall be stored and mixed in a well-ventilated location as designated or approved by ENGINEER. Paints and related materials shall be stored in an area that is protected in accordance with NFPA Bulletin No. 101. They shall be kept in a neat condition and shall be sealed or covered when not in use. Empty containers shall not be allowed to accumulate on the premises. Oily waste rags, etc., shall be collected each day and destroyed or stored in a tightly covered metal container.
- E. Comply with manufacturer's recommendations regarding environmental conditions under which coatings and coat systems can be applied.
- F. During surface preparation, CONTRACTOR shall take all precautions necessary to protect related Work. Equipment items and Work areas shall be tightly covered so as not to be damaged by the painting operation. Special attention shall be made to protect equipment items during sandblasting operations.
- G. CONTRACTOR shall be responsible for clean up of painting materials upon completion of Work.
- H. As soon as painting Work is accepted by CONTRACTOR, it shall become its responsibility for protection, final cleaning, and touch-up.

Piping Color Schedule - Wastewater Treatment

Type	Base Color	Bands*
WATER LINES		
Finished or Potable	Dark Blue	
Service or Nonpotable	Light Blue	Black
Circulating - Hot and Return	Dark Blue	Red
Deionized	Dark Blue	White
Tempered	Dark Blue	Light Gray
CHEMICAL LINES		
Alum	Orange	
Caustic	Yellow	Green
Polymer Solution	Purple	
Chlorine (Gas or Solution)	Yellow	
Ferric Chloride Solution	Orange	
Fluorosilicic Acid	Light Blue	Red
Sulfur Dioxide	Yellow	Red
WASTE LINES		
Raw Sludge	Brown	Black
Sludge Recirculation Suction Line	Brown	Yellow
Sludge Draw Off Line	Brown	Orange
Sludge Recirculation Discharge Line	Brown	
Sludge Gas Line	Red	
Sewer (Sanitary, Discharge, or Other)	Dark Gray	
Final Effluent	Light Gray	
Supernatant	Light Green	Dark Green
Scum	Light Gold	
Drainage and Vent	**Black	
Mixed Liquor (Combined Flow of Raw or Settled with Return Sludge)	Light Brown	
MISCELLANEOUS ITEMS		
Vacuum	Black	White
Compressed Air	Dark Green	
Natural Gas	Safety Red	Black
Fuel Oil/Diesel	Safety Red	
Steam Supply and Return	Safety Red	White
Sample Piping	To match piping sampled	
Electrical Conduit	**Light Gray	
Pumps, Valves, and Compressors	To match piping color of line it serves	
Low Pressure Air and Blowers	Black	Light Gray

* Banding shall be 6 inches wide at 30-inch c/c.

** When exposed to the building interiors above the basement areas, the color shall match the adjacent finish.

END OF SECTION

SECTION 09961 - HIGH PERFORMANCE COATINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied.
 - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
 2. Environmental Protection Agency (EPA).
 3. International Concrete Repair Institute (ICRI) Guideline No. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 4. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 5. ANSI / NSF International (NSF): 61, Drinking Water System Components- Health Effects.
 6. National Association of Pipe Fabricators (NAPF)
 - a. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
 7. Occupational Safety and Health Act (OSHA).
 8. The Society for Protective Coatings (SSPC):
 - a. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - b. SSPC-PA 3, Guide to Safety in Paint Applications.
 - c. SSPC-SP 1, Solvent Cleaning.
 - d. SSPC-SP 2, Hand Tool Cleaning.
 - e. SSPC-SP 3, Power Tool Cleaning.
 - f. SSPC-SP 5/NACE 1, White Metal Blast Cleaning.
 - g. SSPC-SP 6/NACE 3, Commercial Blast Cleaning.
 - h. SSPC-SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SSPC-SP 10/NACE 2, Near-White Blast Cleaning.
 - j. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
 - k. SSPC-SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
 - l. SSPC-SP 13/NACE 6, Surface Preparation of Concrete.

- m. SSPC-SP 16, Brush-off Blast cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
- n. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
- o. SSPC-TU 11, Inspection of Fluorescent Coating Systems.
- 9. National Fire Protection Association (NFPA).
- 10. American Society for Testing and Materials (ASTM International).

1.02 SUMMARY

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.
- C. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- D. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- E. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- F. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.
- G. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by Contractor prior to any storage or installation.
- H. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated.
- I. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

- J. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.
- K. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. **ALL PIPING SHALL BE COMPLETELY PAINTED.**
- L. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.
- M. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- N. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
1. No Factory Finish: Surface preparation, priming, and finish painting.
 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
 5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
- O. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- P. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
1. Exterior exposed concrete surfaces and exterior exposed concrete surfaces below the ground floor plan.
 2. Nonferrous metals and stainless steel, except copper and brass.
 3. Exterior aluminum siding.
 4. Nonexposed surfaces of treated lumber.
 5. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.
 6. Conduits below the main floor, except in rooms that are painted.
 7. Exterior gratings with a hot-dipped galvanized finish.

8. Manufacturer's name and identification plates, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
9. Overhead sectional doors - shall have a factory finish on both interior and exterior exposed surfaces.
10. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by Engineer.
11. Interior concrete surfaces of tanks and basins, immersed and exposed not to be painted.
12. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motors, and fan shafts will not require finish painting.

1.03 DEFINITIONS

A. Terms used in this section:

1. ASTM D 16, unless otherwise specified.
2. Coverage: total-minimum dry film thickness in mils or square feet per gallon.
3. DFT: Dry Film Thickness – Thickness of a coat of cured paint measured in mils (1/1000 inch).
4. FRP: Fiberglass Reinforced Plastic.
5. HCl: Hydrochloric Acid.
6. MDFT: Minimum Dry Film Thickness, mils.
7. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
8. Mil: Thousandth of an inch.
9. PDS: Product Data Sheet.
10. PSDS: Paint System Data Sheet.
11. PVC: Polyvinyl Chloride.
12. SFPG: Square Feet per Gallon.
13. SFPGPC: Square Feet per Gallon per Coat.
14. SP: Surface Preparation.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit in accordance with Division 1 Submittal Procedures.
 - a. Data Sheets:
 - 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
 - 2) For each paint system, furnish a Paint System Data Sheet (PSDS).

- 3) Technical and performance information that demonstrates compliance with Specification.
- 4) Furnish copies of paint system submittals to the coating applicator.
- 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
- b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
 - a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
 - b. Reference Panel:
 - 1) Surface Preparation:
 - a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
 - b) Provide panel representative of the steel used; prevent deterioration of surface quality.
 - c) Panel to be reference source for inspection upon approval by Engineer.
 - 2) Paint:
 - a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
 - b) Furnish additional samples as required until colors, finishes, and textures are approved.
 - c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Typewritten schedule of Painting Operations. This schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and number of coats in order to achieve the specified dry film thickness, and color charts.
2. Coating manufacturer's Certificate of Compliance, in accordance with Division 1, Manufacturers' Field Services.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.

6. Manufacturer's written instructions and special details for applying each type of paint.

C. Warranty:

1. Submit manufacturer's standard warranty in accordance with requirements of Division 1, warranties covering the items included under this Section.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. SSPC PA 3, Guide to Safety in Paint Applications.
 - c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

D. Pre-application Meeting:

1. Convene a pre-application meeting two [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer's representative. Review the following:
 - a. Environmental requirements.
 - b. Protection of surfaces not scheduled to be coated.
 - c. Surface preparation.
 - d. Application.
 - e. Repair.
 - f. Field quality control.
 - g. Cleaning.
 - h. Protection of coating systems.
 - i. One-year inspection.
 - j. Coordination with other work.

- E. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.
- F. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
 - 1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
 - 2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
- B. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
 - 1. Name or title of material.
 - 2. Fed. Spec. number, if applicable.
 - 3. Manufacturer's stock number, batch number, and date of manufacturer.
 - 4. Manufacturer's name.
 - 5. Contents by volume, for major pigment and vehicle constituents.
 - 6. Thinning instructions.
 - 7. Application instructions.
 - 8. Color name and number.
- C. Storage:
 - 1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
 - 2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.
 - 3. Handling: Protect materials during handling and application to prevent damage or contamination.
 - 4. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
 - 2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.
 - 3. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
 - 4. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
 - 5. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
 - 6. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer's printed instructions.
- B. Status of Existing Coatings:
 - 1. Perform tests as required to verify condition of existing coatings and substrate conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
 - 1. TNEMEC Company, Inc.
 - 2. The Sherwin-Williams Company (Basis of Design).
 - 3. PPG Industries.
 - 4. Carboline.

2.02 ABRASIVE MATERIALS

- A. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
- B. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
 - 1. Manufacturer's highest quality products suitable for intended service. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.
 - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
 - 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
 - 4. Color Pigments: Pure, non fading, applicable types to suit substrates and service indicated.
 - a. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non volatile (dry film) of paint by weight.

B. Products:

Product	Definition
Acrylic Latex	Single-component, 100% acrylic finish as required
Block Filler	Primer-sealer designed for rough masonry surfaces, acrylic emulsion, cementitious acrylic, or epoxy
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type, suitable for immersion service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surface, nonshrinking, suitable for application to concrete and masonry
Epoxy Nonskid (Aggregated)	100% solids two-component catalyzed epoxy aggregated; aggregate may be packaged separately
Epoxy Primer-Ferrous Metal	High-build, two-component catalyzed epoxy primer.
Epoxy Primer- Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated

Product	Definition
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	High-build, two-component catalyzed epoxy, capability of 3 to 5 MDFT per coat
Epoxy Novolac	100% solids two-component, highly chemical resistant epoxy
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.
Gloss Polyurethane -	Two-component, aliphatic acrylic based polyurethane; high gloss finish
Multipolymeric Matrix Coating	Heat resistant single component inert multipolymeric matrix coating for high heat applications under insulation.
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

- A. Multiple-Component Coatings:
 1. Prepare using each component as packaged by paint manufacturer.
 2. No partial batches will be permitted.
 3. Do not use multiple-component coatings that have been mixed beyond their pot life.
 4. Furnish small quantity kits for touchup painting and for painting other small areas.
 5. Mix only components specified and furnished by paint manufacturer.
 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
- B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 1. Colors: Formulate paints with colorants for reasons of color or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer or their representative, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.
- D. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations. At completion of work of other trades, touch up and restore all damaged or defaced painted surfaces.

3.02 EXAMINATION

- A. Factory Finished Items:
 - 1. Scheduling Inspection with Engineer before repairing damaged factory finished items delivered to Site.
 - 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.
- C. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.
- D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition, or as required by this specification, the more stringent requirements shall apply.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
 - 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
 - 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
 - 4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
 - 5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

- B. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
 - 2. Refer to coating systems for degree of abrasive blasting required.
 - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

3.05 SURFACE CLEANING

- A. Brush-off Blast Cleaning:
 - 1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
 - 2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
 - 3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
 - 4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
 - 5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
 - 6. Repair or replace surface damaged by blast cleaning.
- B. Solvent Cleaning:
 - 1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
 - 2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

- A. General:
 - 1. The intention of these Specifications is for existing and new interior masonry, interior and exterior wood, and metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
 - 2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
 - 3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.

4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
7. Keep paint materials sealed when not in use.
8. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
9. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
10. Provide finish coats which are compatible with prime paints used.
11. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
12. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.
13. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
14. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

B. Porous Surfaces, Such As Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.

3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.
- C. Film Thickness and Coverage:
1. Number of Coats:
 - a. Minimum required without regard to coating thickness.
 - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
 2. Application Thickness:
 - a. Do not exceed coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
 3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
 4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
 5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
 6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. The Finish Schedule on Architectural Drawings addresses walls, floors and ceilings for various buildings. Additional requirements are included in the following schedule which addresses structural steel, prefabricated steel trusses, process equipment, pumps, piping and other items.
- C. NSF International approval required for coatings used in contact with the water treatment plant process water.
- D. **System No. 1** Chemical Resistant Concrete Floor / Secondary Containment (hazardous chemical exposure)

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Urethane Cement Vapor Barrier / Surfacers	Manufacturer Recommended Primer – 4.0 to 6.0 mils DFT 2 coats – 15.0 – 20.0 mils DFT

Verify resistance to stored commodities and anticipated traffic load PRIOR to installation.

3.08 FIELD QUALITY CONTROL

- A. Testing Equipment:
 1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
 2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
 3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.
- B. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- C. Unsatisfactory Application:
 1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 3. Repair defects in accordance with written recommendations of coating manufacturer.
- D. Damaged Coatings, Pinholes, and Holidays:
 1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.

3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.
- E. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:
1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.
 2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.
- F. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.09 MANUFACTURER'S SERVICES

- A. In accordance with Division 1, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
1. On first day of application of any coating system.
 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
 3. As required to resolve field problems attributable to or associated with manufacturer's product.
 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.
 - a. Inspection Reports: Submit written reports to Engineer and Contractor describing inspections made and actions taken to correct nonconforming work. Report nonconforming work not corrected.
 - b. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.10 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. As soon as painting Work is accepted by Contactor, it shall become its responsibility for protection, final cleaning, and touch-up. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color. Repair coating defects in accordance with manufacturer's written instructions.
- E. Upon completion of painting work, clean window glass and other paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.11 ONE-YEAR INSPECTION

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.
- C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

END OF SECTION

SECTION 11285 - HYDRAULIC GATES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- B. Products Furnished But Not Installed Under This Section: Wiring to motor operators and limit switches shall be done under Division 16.
- C. Items furnished under this Section shall be erected under Section 15100. Mechanical joint gaskets for gates shall be furnished and installed under Section 15100.
- D. Anchor bolts shall be installed Division 3 in accordance with certified prints furnished by equipment manufacturer.
- E. Related Sections: Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 Specification Sections, including Section 01600, apply to Work of this Section.

1.02 REFERENCES

- A. ASTM References:
 - 1. A 126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A 276 Stainless Steel Bars and Shapes.
 - 3. A 304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements.
 - 4. A 582 Free-Machining Stainless Steel Bars.
 - 5. B 21 Naval Brass Rod, Bar, and Shapes.
 - 6. B 98 Copper-Silicon Alloy Rod, Bar, and Shapes.
 - 7. B 209 Aluminum and Aluminum-Alloy Sheet and Plate.
 - 8. B 308 Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded.
 - 9. B 584 Copper Alloy Sand Castings for General Applications.
- B. ANSI References:
 - 1. B 16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- C. AWWA References:
 - 1. AWWA/ANSI C501 Sluice Gates.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Each gate, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Gate Schedule.

- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- C. Warranty: Submit in accordance with Section 01770, warranties covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the specified requirements, manufacturers offering products which may be included in Work include:
 - 1. Rectangular Butterfly Valve or Gate (RB)
 - a. Henry Pratt
 - b. Hydrogate
 - 2. Sluice Gates:
 - a. [Hydro Gate](#).
 - b. [Rodney Hunt](#).
 - c. [Waterman](#).
 - 3. Fabricated Stainless Steel Slide Gates:
 - a. [Hydro Gate](#).
 - b. [Rodney Hunt](#).
 - c. [Waterman](#).
 - d. Whipps Inc.
 - 4. Electric Motor Open-Shut Service Operators:
 - a. [Rotork](#).
 - 5. Electric Motor Operators for Throttling Service:
 - a. [Rotork](#).

2.02 COMPONENTS

- A. Rectangular Butterfly Valves (RB):
 - 1. Rectangular butterfly valves shall be resilient seated and shall be bubble tight at rated pressures with flow in either direction.
 - 2. Valve design shall be rated for 10 psi working pressure and 15 psi test pressure. They shall be satisfactory for applications involving throttling service through the entire range of flow – open to closed. Valves shall withstand frequent operations and for applications involving valve operation after long periods of inactivity.
 - 3. Valve discs shall rotate 90 degrees from the full open position to the tight shut position.
 - 4. When subjected to the maximum design head, a stress safety factor of 3.0 on the yield point or 5.0 on ultimate strength, whichever is lower, shall not be exceeded.
 - 5. Valve Bodies: The valve body shall be fabricated of ASTM A36 carbon steel. Upper trunnion shall be recessed bored for Chevron packing.
 - 6. Valve Disc:
 - a. The valve disc shall be fabricated of ASTM A36 carbon steel.
 - b. Seating edge shall be Type 316 stainless steel and shall be ground, polished and contoured.
 - c. Disc shall be streamlined in shape to prevent turbulence in the full open position and to minimize pressure drop across valve.

7. Valve Seat:
 - a. The resilient valve seat shall be contained in the body of the valve. A seating face shall be furnished around the periphery of the disc.
 - b. Resilient valve seats shall be resilient natural rubber or synthetic rubber Buna N. Seating face shall be type 316 stainless steel.
 - c. Retaining screws shall be of Type 316 stainless steel.
 - d. Seat adjustment possible and inherent in the design shall not be less than 1/8 inch and be fully field adjustable and replaceable without dismantling operator, disc or shaft. No special tools shall be required for this operation.
8. Valve Shafts:
 - a. Valve shafts shall be the stub type with shafts extending into the disc for a minimum distance of at least 1.5 shaft diameters.
 - b. Shafts shall be securely locked to the disc by Type 316 stainless steel taper pins.
 - c. A shaft seal shall be provided where the valve shaft projects through the body for the actuator connection. The seal shall be of a type utilizing a stuffing box and packing gland, so that the packing can be adjusted or completely replaced without disturbing any part of the valve or actuator assembly. Packing shall be of the graphite impregnated, lattice braid square type, as approved by the Engineer.
9. Valve Bearings:
 - a. Main shaft bearings shall be self-lubricated sleeve type fitted into each valve body trunnion bore. Unit bearing stress shall not exceed 4000 psi.
 - b. Each valve assembly shall be furnished with a two-way thrust bearing assembly designed to hold the disc centered in the valve seat at all times.
 - c. Thrust bearing shall be secured by locking device and easily accessible for field adjustment from operator end of the valve.
10. Valve Operators: Valve operators shall be motor actuated with manual over-ride as specified in this Section of the Work.

B. Sluice Gates (S):

1. Sluice gates shall meet the requirements of AWWA C501 and be furnished complete including gate, thimble, rubber gasket, mounting hardware, anchor bolts, and appurtenances as listed on Schedule or shown on Drawings.
2. Sluice gates shall be furnished with ASTM A 126, Class B, cast iron items, seating faces made of strips of ASTM B 21, Alloy A or B, extruded bronze, wedges, thrust nut, lift nut, or stem block, and stem couplings shall be ASTM B 584, Alloy 8A or B 584, Alloy B bronze. Assembly bolts, unless otherwise noted, shall be bronze per ASTM B 98 Alloy A, B, or D. Studs, nuts, anchor bolts, and stems shall be ASTM A 276, 304, or ASTM A 582-303 stainless steel. Holes shall be made by drilling.
3. Sluice gate reinforcing ribs shall be designed to uniformly distribute wedge pressure and shall consist of a horizontal rib terminating at each wedge or heavy vertical ribs located along each side of the gate.
4. The seating face shall be mounted in full width dovetail slots and held in position without use of screws or other fasteners. After mounting, the seating faces shall be machined to a plane with a 32 micro-inch finish, or better. When the slide is in the fully closed position and wedged into position against the frame, the maximum clearance between seating faces shall not exceed 0.004 inch.
5. The side wedges shall be a tongue and groove type assembly, solid cast bronze, and keyed to the cast iron pads to maintain true alignment by preventing undesirable rotation or lateral movement. The wedge shall be attached to the slide by means of a bronze stud, hex nut, and washer. Top and bottom wedges shall be solid cast bronze, nonrotating, adjustable with a

locking device, and attached to the frame with two stainless steel fasteners. Mating and contact faces on wedging devices shall be fully machined. Wedges shall be located at corners and at disc stiffeners as required. Top and bottom wedges are not required on gates below 8 feet unseating head.

6. Normally, Type "F" wall thimble shall be furnished for mounting sluice gates. Type "E" wall thimbles shall be furnished if recommended by the manufacturer for high unseating pressures. Special wall thimbles shall be furnished if noted on Schedule. A center ring water stop shall be around the periphery of the thimble. The front face of the thimble shall be machined, and holes drilled and tapped to attach the gate. Cored holes will be allowed only if specifically shown on Drawings.
7. Stem sizing must be designed to accept the maximum thrust of the operator based on 100 foot-pounds being applied to the operator. Stem size in conjunction with bronze bushed stem guides shall limit the L/r ratio to 200 maximum. Stems of more than one section shall be jointed by bronze or stainless steel, couplings threaded and keyed to the stems. The contact surface of the stem threads shall be machined to a plane with a minimum 32 micro-inch finish or better.
8. Operators shall be as specified herein and shown on Schedule.

2.03 ACCESSORIES

A. Operators:

1. Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to maintenance shall be easily accessible.
2. Manual operators shall be so sized that a maximum of 80 pounds of rim force per pull is required for operation.
3. Positions of operators shall be approved by ENGINEER.
4. Gate shall be made to open when turned to the left or counterclockwise.
5. The direction of the operator to open position shall be indicated on the operator.
6. Bevel Gear: Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
7. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
8. Chainwheel: Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
9. Handwheel: Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
10. Wrench Head: Wrench heads shall be cast iron with set screw. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.
11. Wrench Nut: Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.

B. Motor Operators:

1. Electric Motor Open-Close Service:
 - a. Electric motor operators for open-shut service shall meet the requirements of AWWA C501 Motor-Operated Lift Mechanisms except as hereinafter specified.
 - b. Controls shall be either "integrally mounted" or separated in a "wall-mounted" enclosure. The type to be supplied will be designated on Schedule. Deviations from Schedule will not be accepted.

- c. Electrical equipment shall be mounted in a NEMA 4 enclosure, unless shown otherwise on Schedule.
- d. Motorized gate operators shall include the motor, reversing starter with remote-local switch, associated gearing, limit switches, torque switches, auxiliary handwheel for manual operation, a mechanical dial position indicator, open-close-stop push-buttons, and accessories as listed on Schedule.
- e. Motorized gate operators scheduled with "wall-mounted" controls shall include the motor, reversing starter and remote-local switch mounted in the valve body or the wall-mounted enclosure at the manufacturer's option, associated gearing, limit switches and torque switches mounted in the valve body, auxiliary handwheel for manual operation, a valve-mounted mechanical dial valve position indicator, the wall-mounted control enclosure, and accessories as listed on Schedule.
- f. The wall-mounted control enclosure shall include gate "open" (amber) and "closed" (green) indicating lights, a remote-local switch even if there is a remote-local switch at the gate body, open-stop-close push-buttons and a terminal strip to accept incoming and outgoing wires.
- g. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
- h. The motor starters shall be the reversing contactor type complete with gang-operated switch, two mechanically interlocking reversing contactors, 120 volt control power transformer when motor voltage is other than 120 volt, thermal overload protection for each phase, and associated wiring.
- i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for the local indicator lights and interlocking. An additional 4 switches shall be provided for remote use.
- j. Torque switches shall be provided in both the open and closed circuits of the operators. The torque switches shall be field adjustable and designed to stop the operator motor when the torque exceeds safe limits for either the operator or the gate. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque-seated valve.
- k. A local mechanical dial position indicator shall be provided on the gate operator to indicate the position of the gate.
- l. Motors shall be standard duty rated, totally enclosed nonventilated, Class B insulated, 60 hertz with voltage and phase as noted on Schedules, especially designed for gate service. The design shall combine low inertia with a high starting and stalling torque. The motors shall be sized to operate the gate slide at a rate of 10-12 inches per minute under the full specified unbalance operating head stated on Specifications. The motor winding temperature rise shall be NEMA standard for Class "B" insulation at the rated service factor load.
- m. Gear case shall be cast iron. Pedestals shall be fabricated steel or cast iron. Stem nut shall be high-tensile bronze.
- n. Mechanical emergency operation in event of power failure shall be provided by a clutchable handwheel drive mechanism completely independent from the motor gearing. Hand operation shall be direct drive permitting fast manual gate operation. Failure of motor gearing shall not prevent emergency handwheel operation. Manual operation shall prevent (disconnect) electrical operation.

2. Electric Motor Throttling Service:

- a. Electric motor operator for throttling service on the gates shall meet the requirement of AWWA C501 Electric Operators except as herein specified. Enclosures shall be NEMA 4 unless shown otherwise on Schedule.
- b. The housing and covers shall be of cast aluminum or cast iron. Mechanical parts shall be designed for safety factor of at least 2. Construction of the operator shall be such that it may be mounted in any position required to facilitate manual operation. Manual operation of the gates shall be possible by a handwheel attached to the mechanism. Power to motor circuit shall be automatically disconnected to prevent accidental electric operation during manual operation. A mechanical dial position indicator shall be provided to continuously indicate valve position. Operator bearings shall be self-lubricating type or lubricated for life before operator is sealed at the factory.
- c. The operator motor shall be heavy-duty with continuous duty rating and totally enclosed and nonventilated. The motor shall be equipped with thermal overload protection.
- d. The power supplied shall be 115V single phase, 208V single phase, 230V single phase, 208/230V 3-phase, or 460V 3-phase, plus or minus 10 percent at 60 hertz as shown on Schedule. The motor supplied shall conform to the voltage specified.
- e. The winding temperature rise shall meet NEMA standard for the class of insulation used at the rated service factor load. The motor shall be for high-torque, variable-speed duty. The motor shall be reversible. A 4-20 mA throttling signal shall be provided by others. Control interface electronics, motor controller, and appurtenances to accept this signal and position the gate between 0 and 90 degrees, based on the value of the throttling signal, shall be provided with the gate operator. The controller shall be provided complete with NEMA 4 enclosure, auto-manual selector switch, and open-close push-buttons. Controller shall be completely solid state; contactors are not acceptable. Motor and controller shall be suitable for over 1,000 starts per hour. Controllers shall accept an isolated 4-20 mA signal for gate positioning from a remote source.
- f. The gear train shall be pre-selected to have open-close operating time from 1-3 minutes as shown on Gate Schedule.
- g. Limit switches shall be provided at the extreme open and close position of the operator travel. At least two independent switches at each end of motor travel shall be provided as standard for a local indicator and interlocking. An additional switch shall be provided at each end for remote use.
- h. Motor circuit limit switches shall be of the direct-break type. Limit switches shall be adjustable. Limit switch contacts shall be isolated. Auxiliary switches for secondary functions shall be of the cam-operated, spring-leaf type. The operator shall be equipped with a torque switch for protection in the closing direction. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque seated valve. In the event of power failure, the operator shall lock in the last control position until power is restored or switched over to standby power, or the manual operating handwheel is engaged.
- i. Torque switches, limit switches, and motor thermal switches are to be mounted as required inside the housing and connected to the master terminal strip. Provisions shall be made for 2 internal potentiometers for feedback on control operations. Wiring within operator shall be incorporated in a standard laced wiring harness using compression connectors and terminal strips. Internal wiring shall be UL approved for 105 degrees C operation. Insulation shall be suitable for 600 volts.
- j. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc.

Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.

C. Miscellaneous:

1. One complete set of wrenches, spanners, and other tools necessary for the adjustment and dismantling of the equipment shall be furnished. Standard open end and pipe wrenches need not be included among these tools, but socket wrenches and offset wrenches, which can be used to better advantage than standard open wrenches, shall be included among the tools to be furnished with the equipment.
 - a. Wrenches and spanners shall be case-hardened steel forgings and shall have a bright finish with working faces dressed to fit nuts.
 - b. The gate shall be shipped as fully assembled as is practicable.
 - c. The shipping crates shall be provided with skids and lifting devices for crane slings.
 - d. Devices not attached to the gate during shipment shall be packed in boxes and properly labeled for assembly. Such equipment shall be shipped machined and fitted. No machining of parts in assembly shall be required.
2. Bench Stand: Bench stands shall meet the requirements of floor stands as herein specified, except that baseplates shall replace pedestals.
3. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
 - a. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.
4. Floor Stand:
 - a. Floor stands shall meet the requirements of AWWA C501 for Manual Operating Mechanism except as herein specified.
 - b. Floor stands shall be a high-strength cast iron pedestal type furnished with lubrication fittings and stainless steel, double-nutted anchor bolts.
 - c. Geared floor stands shall have weatherproof housings.
 - d. Floor stands shall be provided with a galvanized steel stem cover and position indicator, and the direction of rotation to open the gate shall be indicated.
 - e. The operating stem will be 304 or 303 stainless steel. On aluminum gates the stem shall be connected to the disc by means of an aluminum angle connection, threaded and bolted for the stem and welded to the disc.
 - f. A sleeve made from standard-weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand.
 - g. Connections of stems to stainless steel or fiberglass gates shall be as per the manufacturer's recommendations.
5. Position Indicator: Position indicators shall be of bronze or cast iron construction.
6. Stem Cover: Stem covers shall be galvanized steel with position indicators and cap.
7. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B construction with bronze bushings adjustable in two directions and furnished with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.
8. Wall Bracket: Wall brackets shall be cast iron and furnished with stainless steel assembly and anchor bolts.

2.04 GATE SCHEDULE KEY

- A. The Gate Schedule provided on Drawings gives the designation for each gate, its location, service size, quantity, and other pertinent data.

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- B. The distance given with extension stems or shafts is that from centerline of port to top of floor at floor stand or floor box, or from centerline of port to ground surface for valve box.
- C. In general, no gates smaller than 4 inches are included on Schedule.
- D. Unless otherwise noted on Schedule, stems shall be of the rising type for gates, service use shall be open-shut; motors shall be 230/460 volt, 60 cycle, 3-phase AC; and enclosures shall be NEMA 4.
- E. Included in the remarks column will be exceptions to class, stem, service, motor, and motor enclosure requirements, etc.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.
- B. Equipment furnished under this Section shall be installed under Section 15100, in accordance with procedures specified there.

3.02 FIELD QUALITY CONTROL

- A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section of the Work are installed in accordance with manufacturer's recommendations.

3.03 EQUIPMENT INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer shall visit Site of Work a minimum of 1 trip, to inspect, check, adjust if necessary, set limit and torque switches, and approve the equipment's installation. The equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Each equipment supplier's representative shall check the equipment installation and furnish to OWNER, through ENGINEER, a written report certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by connecting conduit or anchor bolts;
 - 4. Limit and torque switches have been set;
 - 5. Verify wiring connections, remote control, and remote control indication feedback.
 - 6. Has been operated under full load condition and that it operated to the satisfaction of ENGINEER;

7. That OWNER's Representative has been instructed in the proper maintenance and operation of the equipment; and
8. Furnish OWNER through ENGINEER a copy of all test data recorded during the installation check.

3.04 OPERATION AND MAINTENANCE TRAINING

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

END OF SECTION

SECTION 11371 - HIGH SPEED TURBO BLOWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. General: Furnish, install and test packaged high speed, air foil bearing turbo blower system. The packaged blower system shall be complete pre-packaged system including blower, premium efficiency motor, variable frequency drive, control panel, plc, inlet filter and silencer, blow-off valve, check valve, discharge valve, connectors and other appurtenances as shown on Drawings and specified herein for complete and operational system.
- B. Refer to system configuration drawing sheet I-100 for requirements on PLC hardware, panelview and ethernet switch information. Manufacturer responsible for providing IO cards as required to suit the process equipment being provided. PLC hardware to be Rockwell. Provide Rockwell panelviews—model as noted. Ethernet switches to be Hirschman—model as noted on drawings.
- C. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- D. Related Work Specified Elsewhere.

Section 13421	Flow Measurement
Section 13428	Analytical Instruments
Section 13430	Control Panels and Consoles
Section 15110	Process Valves
- E. Products Furnished But Not Installed Under This Section. Anchor bolts shall be installed under “Concrete” Section of Work in accordance with certified prints furnished by the equipment manufacturer.
- F. The system design is based on APG Neuros (Basis of Design). The aeration blowers are integral to the aeration system operation, performance and layout. Approval by ENGINEER is required for any proposed deviations from the basis of design.

1.02 REFERENCES

- A. Reference Standards:

1. ASME PTC-13	Wire to Air Performance Test Code for Blower Systems
2. AWWA C-504, Class 25	Butterfly Valves
3. ASTM A 126, Class B	Cast Iron
4. ASTM A 48, Class 40	Cast Iron
5. ASTM A 278, Class 40	Cast Iron
6. ASTM A 148, Class 9A	Aluminum Bronze
7. ASTM A 436, Type 1	Ni-resist
8. ASTM A 536, Class 65-45-12	Ductile Iron
9. ASTM B 147, Class 8b	Aluminum Manganese Bronze
10. ANSI B16.1, Class 125	Flange Joint
11. ASA, Class 125	Flange Joint
12. AFBMA C-10	Bearing Life
13. AGMA	Gear Rating
14. ASTM B 61	Cast Bronze

1.03 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Design conditions and performance requirements are as indicated in the schedule provided at the end of this Section.
 - 1. Manufacturer shall meet guaranteed performance requirements for the design conditions indicated in the schedule and provided with blower bids.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer shall furnish a tentative schedule and an outline of services to be performed by their representative to meet the requirements described herein.
- B. Product Data: The following is to be supplied by manufacturer:
 - 1. General Description of blower with all performance data, blower curves, and model.
 - 2. Mechanical Drawings with general arrangement showing blower base dimensions, floor mounting, skid piping, overall weights , and weights of largest components requiring removal for maintenance.
 - 3. Process and Instrumentation diagrams.
 - a. Control Panel drawings shall include:
 - 1) Interconnects to all components outside the panel
 - 2) Sample Operator interface screens for the local and master control panel.
 - 3) Local Control Panel interconnect wiring diagrams
 - 4) Plant SCADA system interconnect wiring diagrams
 - 5) PLC address points for remote monitoring and control (In addition to the preconstruction submittal, Contractor to provide an as commissioned list indicating any changes during installation and startup)
 - 6) PLC logic and panelview graphics shall conform to the owners existing software programming standards. Coordinate with Owner prior to programming of these manufacturer supplied systems.
 - 7) Coordinate with Tetra Tech on any signals needed from the existing plant wide SCADA system for automatic operation of the manufacturer supplied systems. These signals will be messaged over the plant wide fiber optic/SCADA network.
 - 4. Operating Description for the local control panels. As a minimum, provide a more detailed description than given in this specification, covering all logic and sequences of operation.
 - a. Furnish to owner actual electronic program copies of the PLC programs and the panelview applications. These applications shall be integrated to the existing plant-wide SCADA system by Tetra Tech.
 - 5. Provide a detailed description that demonstrates the simultaneous, automatic, and continuous efficiency optimization of the blower to obtain the lowest power consumption based on the three (3) variables of inlet temperature, differential pressure, and machine capacity.
 - 6. Preliminary /output (I/O) listing shall be shown on electrical schematic drawings. Coordinate IP addresses with OWNER.
 - 7. Blower Tests – Submit a detailed test plan with complete piping and instrumentation configuration diagram per ASME PTC-13 showing inlet and discharge air test pipe size. The location, type, and quantity of all major instruments necessary for performance data, including those on air, water, and lube oil with corresponding distances from reference points, shall be identified per ASME PTC-13 requirements. As a minimum, the detailed test plan shall include:

- a. Quality control procedures
 - b. ASME PTC-13 test procedure and method of calculating results
 - c. Functional testing of entire package instrumentation, ancillary components, cooling system, and the LCP's
 - 8. Surface preparation and shop paint specifications.
 - 9. Miscellaneous Technical Information
 - a. Safety Precautions
 - b. Receiving and Handling
 - c. Storage Requirements
 - d. Allowable load on compressor discharge flange
 - e. Recommended lubricants
 - f. Suggested preventative maintenance
 - g. Blower manufacturer's service and spare part capabilities
 - h. Recommended spare parts
 - i. Installation list
 - j. Warranty
 - 10. List of components with Manufacturer and model number information.
 - a. Mechanical and structural components
 - b. Instruments
 - c. Programmable Logic Controller (PLC)
 - d. Operator Interface/machine monitors
- C. Tests and Inspection Reports: A written reports shall be submitted to ENGINEER documenting the results of test and/or inspections. The report shall be prepared as noted under Section 01600.
- 1. Shop test reports shall be neatly bound and shall include a written test description, arrangement drawings, instrument descriptions, actual test data sheets, computation results, description of formulas used, and resulting test curves. The following reports shall be submitted prior to final equipment acceptance:
 - a. Shop Test Report
 - 1) Evaluation Warranty Shop Test (ASME PTC-13 Test)
 - b. Initial Inspection and Startup Report
 - c. Performance Test Report
 - d. Alignment (Millwright's) Report.
 - e. Dynamic Balance Test Report
 - f. Complete Air System Functional Test
- D. Operation Review Report: A written "Operation Review Report" will be submitted to OWNER and ENGINEER following the 1-year aeration equipment review described in Part 3.
- E. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- 1. Manufacturer shall provide written instructions for operating equipment furnished. These instructions should be short, easy-to-understand directions specifically written for this Project describing the various possible methods of operating the equipment including tests which may be required to be made by the operator. The instructions should also include starting and stopping sequencing and precautions to be taken by operating personnel with the equipment.
- F. In addition to the above, Operation and Maintenance manuals shall include:
- 1. Unloading, handling, storage, and maintenance requirements
 - 2. Recommended spare parts list and those supplied per specifications

3. Recommended lubricants
 4. Instrument settings
 5. Troubleshooting guide
 6. Suggested preventative maintenance schedule
 7. Sample blower data log
- G. Warranties: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.
- H. Blower: The blower manufacturer will submit a certified test report attesting to the date and place of dynamic balance and the accuracy achieved.

1.05 WARRANTY

- A. Special Warranty
1. The blower manufacturer shall warrant the blowers against defect in workmanship, materials and operation for a period of five years under normal use, operation, and service. The blower manufacturer shall also include in the warranty a progressive schedule of cost for a period of five years on certain parts that become defective through normal use and wear. The warranty shall be in published form and submitted with each blower at the time of shipment. The warranty period shall commence after blower start-up and component acceptance by OWNER.

1.06 QUALITY ASSURANCE

- A. Tests: Shop and performance tests shall be conducted as specified and shall meet the requirements of ASME PTC-13 2019 The following tests are to be performed:
1. Shop Test:
 - a. General Shop Test: To certify compliance with specification requirements.
 - b. Evaluation Guarantee Shop Test (ASME PTC-13 Test)
 2. Performance Test: To verify acceptable field operation.
- B. Certified Performance Curve: Certified performance curves, compiled from shop test data, shall be furnished as specified under "Shop Tests" and shall be included in the Shop Test Report. Testing shall be in conformance with the ASME "Code for Testing Centrifugal Compressors and Exhausters" as specified.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The blowers will be used for supplying a variable volume of air to the aeration basin. All items specified in this section shall be supplied by the Manufacturer to provide a sole source responsibility for a properly functioning aeration blower system with the objective to minimize power consumption while providing the air to each . All components shall be new. Both workmanship and materials shall be of the very best quality and conform to all applicable sections of these specifications. It shall be understood that components specified establish minimum requirements only, and do not relieve the Contractor of responsibility for providing a properly functioning system.

- B. The blowers shall be motor driven, air bearing type that shall not require oils or lubricants for adequate operation, capable of variable speed operation with a minimum turndown to fifty percent (50%) using an integral variable frequency drive. The blower shall be capable of operating continuously and satisfactorily at any point between the minimum and maximum flows without any surge. The blower shall be designed to operate at optimum specific speed in order to maximize efficiency and reduce motor speed.

2.02 MANUFACTURERS

- A. Subject to compliance with specified requirements manufacturers offering products which may be included in Work include:
 - 1. High Speed Blower:
 - a. APG-Neuros, Inc.
 - b. Or Approved Equal
- B. The air blower mechanical components, actuators, accessories, instruments, controls, and aeration control system shall be supplied by a single Blower Manufacturer who is fully experienced, reputable, and qualified in the supply of the equipment specified. The Manufacturer shall have at least ten (25) installations of high speed turbo blowers in North America that have been in operation in wastewater treatment applications. Submit evidence of conformance to experience requirements for the blowers. Lack of evidence, with details matching each specific requirement is cause for rejection of the Manufacturer.
- C. All control panels provided shall be designed, constructed, and tested “in-house” by the Manufacturer. This work shall not be outsourced, the purpose being to ensure quality assurance, control, and testing by the Manufacturer in an ISO 9001 certified shop.
- D. The Manufacturer’s machining and assembly shops must be ISO 9001 certified in order to assure conformance to the highest quality standards of the industry.
- E. The listing of any Manufacturer by name shall not imply tacit approval of same. The selected Manufacturer shall be required to meet the specifications. Equipment which is a “standard product” with the Manufacturer shall be modified, re-designed from the standard mode, if necessary, or furnished with special features, accessories, materials, or finishes as may be necessary to conform to the detailed requirements of these specifications and contract drawings.
- F. Any modifications from that shown in the contract drawings shall be the Contractors responsibility, at no additional cost to the Owner.

2.03 COMPONENTS

- A. High Speed Blower
 - 1. Blower shall be designed to maintain a minimum rise to surge margin of 0.5 psig away from surge at any point in its capacity range.
 - 2. Blower impeller shall be of backswpt design milled from forged aluminum alloy. The first lateral critical speed shall be at least 120% of the maximum allowable speed. The impeller shall be mounted directly to motor shaft and shall be statically and dynamically balanced.
 - 3. Bearing shall be sized for a minimum of expected 10 years between major overhaul.
 - 4. The blower shall be supplied with a sound enclosure covering the entire blower package. The enclosure shall be designed for easy inspection and maintenance of the blower components.

5. The blower shall not allow heat caused by the motor or electrical cooling to be exhausted into the blower room.
6. The blower shall be supplied with built in vibration isolating mounts.
7. The unit shall include a stepdown transformer located within the blower enclosure to transfer incoming 4160V power to 480V for the unit.

B. Motor

1. The motor shall be a Permanent Magnet Synchronous (PMSM) high speed motor suitable to be driven by variable frequency drive operating on 460/480 V, 3 Phase, 60 Hz power.
2. The maximum allowable horsepower shall be listed on Schedule.
3. The drive motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.15 service factor.
4. Class "F" insulation or better.
5. The motor shall have bump-foil air bearings.
6. The motor shall be monitored by PLC.
7. The motors shall be rated for inverter duty in accordance with NEMA MG1-1993, Rev. 1, Part 31, Definite Purpose Inverter-Fed Motors," and shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seconds.

C. Inverter/VFD

1. The variable frequency drive unit shall convert 480 volt plus 10 percent, minus 5 percent; 3-phase; 60 hertz plus or minus 2 hertz, input power into an adjustable frequency output. Output power shall be of suitable capacity and wave form to provide stepless speed control of the specified AC motor throughout a continuous speed range of 10:1 under variable torque load not exceeding 1.15 times the motor's full load rating in an ambient of 0-40 degrees C with up to 95 percent humidity. The drive continuous run amperes rating shall be 1.15 times the full load ampere of the load. The drive shall be able to withstand external short circuits without fuse blowing or device failure
2. Provide instantaneous static overvoltage and overcurrent protection. Provide undervoltage trip upon input power loss or phase loss without component failure and automatic restart upon return of full power and command. The drive shall not be damaged by application of incorrect phase sequence.
3. The blower shall be equipped with a high efficiency Variable Frequency Drive with 97% efficiency at full rated motor speed and power.
4. The VFD shall be supplied with passive harmonic filters that reduces the THD to less than 8% in compliance with IEEE 519 rating. The filters shall be supplied by Artech, Mirius International or approved equal. Filter shall be mounted in blower skid control panel (load side of the control panel disconnect switch).
5. The VFD shall have a sinusoidal filter on its output consisting of an inductor and capacitor filter.
6. The VFD shall have fault detection circuit with contacts for remote alarm used by others. The drive shall shut down on any type of failure. Cause of drive shutdown shall be displayed on operator interface.
7. The VFD shall have forced air ventilation system to remove heat from the drive enclosure. Power for the ventilation system shall be provided from the drive circuits.
8. All wires are to be identified, and the identifying mark shown on the schematics and wiring diagram. Documentation of schematics, wiring diagrams, terminal strips, and operating and maintenance manuals shall be supplied at Shop Drawing time and delivered with the equipment.
9. The VFD manufacturer or service representative shall supply all circuit protection inform for feeder breakers. This information shall include at a minimum:

- a. Long Time Setting
 - b. Short Time Setting
 - c. Instantaneous Setting
 - d. Ground Fault Setting
 - e. Fuse Style, Type, Size
 - f. Breaker coordination
10. Meet OSHA, and NEC recommendations for signage for:
- a. Lockout/tagout
 - b. Arc Flash
 - c. Safe working distances
 - d. Power feeder information (type and location)

D. Power Supply

- 1. The Contractor shall provide and wire the power supply to the blower unit. Blower manufacturer shall provide 460V and 120V power to their system from the internal stepdown transformers. All wiring within the panel shall be grouped together in harnesses and secured to the structure. The LCP shall be factory assembled and wired such that Contractor field wiring shall consist only of connection to terminals. Each assembled control panel shall carry a UL label certifying the assembled industrial control panel complies with UL 508A.

E. Accessories

- 1. Each blower shall include a flexible expansion connection to the discharge piping.
- 2. Each blower shall have a wafer style dual vane check valve on the discharge.
- 3. Blower shall have a manual operating butterfly valve with 316 stainless steel disc and 416 stainless steel stem, as indicated in Valve Schedule of Contract Documents.
- 4. Blower shall have a integrated blow-off valve actuated by blower pressure.
- 5. Each blower shall have an integrated combination intake/inlet filter/silencer system. Intake performance losses shall be included by the blower manufacturer in performance calculations. Blower intake shall be connected to the existing intake piping within the blower room. The pre filter shall have removal efficiency of 90% at 10 microns. The final filter media shall have an efficiency of greater than 98% at 10 microns. Filter element shall be removable without disconnecting the inlet pipe and shall be washable by maintenance personnel.
- 6. Instrumentation, the following items shall be integrated into the system and shall have 4-20mA output signals.
 - a. Inlet pressure sensor for filter monitoring
 - b. Discharge Pressure sensor
 - c. Inlet and Discharge temperature sensor
 - d. Bearing Temperature sensor
 - e. Motor temperature sensor
 - f. Vibration sensor
- 7. Spare Parts
 - a. Furnish a list of recommended spare parts with Operation and Maintenance Manual.
 - b. Furnish one set of special tools required for complete assembly and disassembly of blower system components for the blowers specified. Tools to shall be provided in a metal box labeled with contents.
 - c. One set of inlet filters for each blower.
 - d. Three spare fuses of each type used.

2.04 CONTROLS AND INSTRUMENTATION

- A. Each blower shall be furnished with an integral PLC-based control panel. All instruments and controls on the unit shall be factory wired to the panel. All controls and instruments shall fail into a safe condition. The controls shall be designed such that the blower cannot operate unless the controls are energized, nor can they operate with any defective controls. PLC's panelview's, and switches to be powered by an on-line UPS. Provide bypass contactor for bypassing the UPS in the event of a failure.
- B. Panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Three phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
 - 1. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
 - 2. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
- C. Each blower LCP shall contain controls for blower motor starting, surge and overload detection, shutdown control and sequencing, alarm and emergency shutdown systems and bypass valve,.
- D. A PLC shall start and shut down the blower in a permissive sequence, receive input, monitor and control operating variables. The PLC shall also contain a program for continuous optimization of blower efficiency with respect to changes in capacity, inlet temperature, and differential pressure across the blower
- E. Isolation amplifiers, R/I transmitters, RTD/vibration transmitters, and other controls shall be supplied, as required, for complete system control.
- F. Identify each end of each wire by a unique wire number printed on a heat shrunk sleeve marker.
- G. Provide a Operator Interface touch sensitive, color monitor screen, minimum 8-inch size that incorporates all controls, alarms, and meters in easy-to-interpret screens. Verify model with the owner prior to installation.
 - 1. Provide the following indicators on the Operator Interface:
 - a. Blower Status – Running/Stopped
 - b. Operator Mode Selections
 - c. System Pressure Display
 - d. Blower Local / Remote Control
 - e. Blower Speed Indications Status
 - f. Blower Run Time
 - g. Blower Amp Draw
 - h. System Pressure
 - i. System Air Flow

2. Operator Interface Displays
 - a. Alarm History
 - b. Operating Status
 - c. Alarm Information
 - d. Daily log/run time
 - e. Setup Menu
 3. Alarms
 - a. Local indication of alarm conditions shall be provided on operator interface.
 - b. All alarm conditions shall be output to Plant SCADA system.

Panelview applications to have at a minimum 3 levels of password security. Coordinate exact requirements with Engineer. The panelview programming shall include at a minimum software manual operation of the equipment from the panelview. Software automatic operation shall be provided as specified herein and as coordinated with Owner/Engineer.
- H. Hardwired Connection
1. Coordinate signal type and state with plant. Contractor shall provide required equipment to connect to plants existing system.
 2. The following outputs shall be provided to each Blower local PLC via a hardwired connection.
 - a. Airflow (Isolated 4-20 mA signal)
 - b. Discharge Air Temperature (Isolated 4-20 mA input signal)
 - c. Blower Running (Isolated Dry Contact rated for 4 amps)
 - d. Blower Faulted (Isolated Dry Contact rated for 4 amps)
 3. The following inputs shall be provided to the plants' PLC via a hardwired connection.
 - a. Remote Command (Isolated or non-isolated 4-20 mA signal)
 - b. Remote Start (Closure contact)
 - c. Remote Stop (Closure contact)
- I. Plant SCADA System
1. The following outputs shall be provided to the plant PLC and SCADA system via Ethernet / IP communication.
 - a. All Alarms
 - b. All equipment status (on/off, Remote/Local, etc.)
 - c. All parameters displayed at operator interface
 - d. Motor Speed
 - e. Airflow
 - f. Discharge pressure
 - g. Blower Running
 - h. Blower Fault
 - i. Remote On
 - j. Remote Speed Control
 - k. Remote Stop
 - l. Remote Emergency Stop
- J. The panel shall be provided with a 480 VAC to 115 VAC, and a 115 VAC to 24 VDC transformer/power supply to power programmable controller inputs and other 115 VAC/24 VDC powered devices. This should be sized appropriately to power all device associated with the blower. (including any items shipped loose)
- K. Master Control Panel (MCP). The blower manufacturer shall coordinate with ENGINEER and OWNER on Blower automation and aeration system control. A dedicated control logix processor (Master PLC) and separate ethernet bridge card and ethernet switch is to be included in the BPP

panel indicated in the CONTRACT DOCUMENTS, see sheet I-100. This will serve as the system master control panel to coordinate functions between the plant SCADA system and the manufacturer aeration control system. The blower manufacture shall be responsible for the entire aeration system performance and compatibility. PLC based sequencing program shall be provided and tested by the Manufacturer for starting and stopping blowers automatically and to facilitate set point control. The Contractor shall provide and wire the 120/60/3, 30 amp power supply.

1. The MCP shall provide air header pressure control over a range of 6 to 12 psig with any or all of the blowers in service. The PLC shall receive the two main air header pressure 4-20 mA signals. An internal PLC algorithm shall compare the two signals, and average the data points, so long as they are within a pre-set differential bracket. If one signal varies outside this differential, an alarm is energized and the remaining signal within a pre-set bracket is used. The main air header pressure variable input is compared with an air header set point, with the MCP directing increase or decrease of on-line blower volume to maintain the pre-set air header pressure. The discharge pressure set point shall be adjustable from the MCP or from a remote serial or analog input provided by others.
2. The MCP shall provide two modes of air header pressure control:
 - a. Fixed mode in which the set point is manually adjusted via controls on the front of the control panel.
 - b. Most open valve control mode in which the pressure set point is based on air flow control valve position. In addition to the air header pressure 4-20 mA signal input, the MCP shall also receive 4-20 mA position signal input from each air flow control valve (valves specified in Paragraph 2.23A). The pressure set point versus valve position function shall be a linear function derived from field operated experiments, which shall be designed and conducted by the Manufacturer to determine the most efficient header pressure throughout the range of valve positions.
3. The blower and aeration system control shall use inputs of DO, air flow, valve position, and main air header pressure to optimize system design, the objective being to operate at the lowest system pressure and DO to affect modulation of air flow to all cells. Should a fouled DO sensor yield a DO level above or below pre-set limits, resulting in incorrect flow modulation to the cell, it shall be ignored and an adjacent DO sensor, diurnal flow, or other back-up mode as established at time of submittal shall be used to adjust the affected flow valve.
4. The MCP shall have process integrating control loops for each aeration cell DO, air flow meter, and air flow control valve. DO in an aeration cell shall be maintained at a pre-set level from the MCP via a manual set point at the MCP for each aeration cell. The air flow meter shall be used as the control function and air flow control valve as the controlled function. The DO probes shall input to the MCP providing a secondary control loop to optimize the air flow rate with DO control. Maximum and minimum air flow set points and warning alarms shall be based on design parameters set during the submittal stages by the Engineers.
5. The PLC shall bring blowers on and off-line and increase/decrease on-line blower capacity based on cascade control logic. The result being a gradual increase/decrease of air throughout the entire range of one (1) to two (2) to three (3) blowers on-line. In the event of a blower failure, the next blower in the pre-selected start sequence shall come on-line.
6. The MCP shall provide surge control of the entire on-line blower system by modulating the main air header blow-off valve as system pressure rises, approaching a surge condition. System surge shall be automatically controlled via a dynamic algorithm based on the blower performance curves, ambient temperature, and the main air header discharge pressure or manually, via blow-off set point from the MCP.
7. The Operator Interface shall have multiple color screens to display operating variables, valve positions, and other relevant data and to select the start sequence of the blowers, pressure set point adjustment and the local/remote selection for local or remote pressure or most open valve

system control. The operation shall be programmed to be user friendly by providing sufficient prompting that an operator can intuitively follow through the commands to operate the blower system.

8. Displays and controls shall be provided to monitor all process variable input for master control and to monitor and modify set points, as required.
 9. The monitor shall display screens identifying the blowers on-line including the lead blower and the ability to modify the lead blower selection.
 10. The monitor shall provide options for control of the blowers and air flow control valves as a manual function, air header pressure controlled via manual set point, or via floating air header pressure set points based on most open valve philosophy. All valve positions shall be displayed with the most open valve being appropriately identified.
 11. The MCP shall have status indicators for each blower as follows:
 - a. Blower in remote
 - b. Blower ready for start
 - c. Blower on
 - d. Common alarm
 12. External signals from the MCP to each LCP shall be as follows:
 - a. Blower start/stop signal
 - b. Increase air flow
 - c. Decrease air flow
 13. Furnish fiber optic patch panels as show on instrumentation drawings.
 14. Furnish ethernet patch cables as shown. Furnish duplex multimode fiber optic patch cables- 50 micron as shown. Connectors as noted on drawings.
- L. Control Panel Design and Testing. The LCP and MCP design, construction, and testing shall be completed "in-house" by the Manufacturer. This work shall not be outsourced, the purpose being to ensure quality assurance, control, and testing by the Manufacturer in an ISO 9001 certified shop. This testing in the Manufacturer's shop shall be completed as specified in Paragraph 1.04C of this specification section.

2.05 SOURCE QUALITY CONTROL

- A. General: Each blower shall be shop tested to verify acceptable operation at the design extreme conditions. All testing shall be made in conformance with the requirements of the ASME "Test Code for Centrifugal Compressors and Exhausters."
- B. Evaluation Warranty Shop Test: Each blower shall be shop tested for capacities, power requirements and efficiencies at all design points of the blower evaluation criteria indicated in the blower schedule.
 1. Each blower shall be tested in accordance with the ASME Power Test Code PTC-13. Tests may be conducted using the job motor or a factory test motor. The test shall include determination of the surge point and verification of the guarantee points. Compressor net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no other tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with \pm zero percent tolerance).
 2. The capacity of the blower shall be defined as ASME PTC-13 Power Test Code. Specifically, capacity is defined as, "the net rate of flow compressed and delivered, expressed in terms of cubic feet per minute at the prevailing inlet temperature and pressure. It shall be measured in a suitable manner to exclude effectively all external leakage losses from sources such as shaft

- seals.” That is, air flow shall be measured on the discharge side of the compressor at zero percent tolerance.
3. All test equipment shall be calibrated and certified by an independent test agency no more than twelve (12) months prior to the test date. Certificates shall show the stability of calibration over a period of at least one year per ISO 9001, Paragraph 4.11.
 4. Velocity vibration versus frequency levels shall be recorded within 10-1,000 and 10-10,000 Hz frequency range.
 - a. The results of the shop test on the compressors and motors or on the compressor units shall be such as will meet CONTRACTOR's warranties and the approval of ENGINEER before the equipment may be shipped. If, in the judgment of ENGINEER, the results of a shop test indicate that the equipment is not capable of fulfilling the warranty made for it by CONTRACTOR, OWNER may refuse to accept the equipment until CONTRACTOR shall have made such modifications in it as make it capable of fulfilling the warranties, or OWNER may accept the equipment and reduce the price as determined by the Energy Use Guarantee.
 5. Complete Air System Functional Test: upon completion of assembly, each blower, motor, skid shall be functionally tested with the local control panel (LCP) connected to all skidded instruments, electric valves, and appurtenances. All start/stop sequences and all safety and alarm systems shall be tested, simulating start of the blower motor. All blowers, motorized valves, local panels shall be demonstrated to the Witnessing Engineers as an operating system before shipment. The Witnessing Engineers shall sign the test procedure and results, certifying that the assembled blowers, auxiliaries, blow-off, discharge, LCP were tested in the Manufacturer's shop.
 6. The shop tests shall be performed in the presence of the ENGINEER or designated Witnessing Engineer selected by the ENGINEER and OWNER.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from time of shipment until installation is completed, and the units and equipment are ready for operation.
- B. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.
- C. Shipment is not to be made until Manufacturer coordinates shipment to the jobsite with the CONTRACTOR and OWNER, assuring that the equipment will be properly received and stored.
- D. Upon receipt, store equipment indoors, in a heated, controlled environment above 50 deg, in strict accordance with the Manufacturer's instructions. Connect and energize motor space heaters.

3.02 ERECTION

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

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ENGINEER. All piping shall be supported so as to preclude the possibility of exerting undue forces and movements on the blower flanges. Each blower unit shall be mounted on a flat level concrete pad (+/- 1/4-inch) in accordance with the recommendations of the Manufacturer.

- B. The CONTRACTOR shall furnish the required piping, pipe supports, flange gaskets, bolts, nuts, pneumatic tubing, oil, grease, for initial operation in accordance with the manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

- A. General: The total minimum manufacturer-supplied services, as herein specified, shall be 12 day with 2 trips to the Site. If there are difficulties in operation of the equipment due to manufacturer's fabrication, additional services shall be provided at no extra cost to the CONTRACTOR and OWNER. If there are difficulties in start up due the CONTRACTOR installation, the CONTRACTOR shall retain the services of the Manufacturer at no extra cost to the OWNER.
- B. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services include checking the equipment prior to installation to review installation procedure, and again following installation, to inspect, check, and adjust if necessary, and approve the equipment installation.
 - 1. Initial Startup
 - a. Provide as a minimum, the following field commissioning
 - 1) Verify proper connection of piping and installation of accessories
 - 2) Field precision alignment of motor, blower, and coupling
 - 3) Check level of base
 - 4) Confirm proper wiring on all instruments and field wired items
 - b. A minimum four hour field run test shall demonstrate that, under all conditions of operation, each unit
 - 1) Has not been damaged by transportation or installation
 - 2) Has been properly installed
 - 3) Has no mechanical defects
 - 4) Has fully functional instrumentation, properly calibrated and set
 - 5) Will start, run and stop in the prescribed manner
 - 6) Will run through the entire range of specified pressure and flow
 - 7) Has the proper shutdown sequence of standard stop, soft stop, and emergency stop
 - 8) Is free of overheating of any parts
 - 9) Is free of objectionable vibration and noise
 - 10) Is free of overloading of any parts
 - 11) Demonstrates the simultaneous and continuous efficiency optimization based on inlet temperature, differential pressure and capacity.
- C. Performance Tests: After installation of the equipment has been completed and as soon as conditions permit, a service representative from blower manufacturer shall be present to check out, start-up and test each blower unit as outlined under Installation Check of the General Requirements. The object of these tests is to determine that the units meet the specifications and to determine surge point and full load point. All instruments, labor, lubrication and other necessary material required to run these shall be provided by manufacturer.
 - 1. OWNER will furnish all required electrical power for testing.

- D. **Manufacturer's Field Service:** Manufacturer shall furnish the services of a representative at the Site to assist CONTRACTOR's personnel in the initial equipment check-out, to supervise equipment base grouting and to assist OWNER's personnel in proper operation and maintenance of the equipment.
 - 1. Manufacturer shall schedule a qualified representative to visit the Site for a 2day period near the end of the first year of the 5-year warranty period to review aeration equipment operation and performances. The schedule of this visit is subject to approval by OWNER.
- E. **Training:**
 - 1. Training shall be provided on site for all appropriate personnel designated by the OWNER. Training shall include system operation and hands-on demonstration of equipment functions and adjustment. Tuning, testing, preventive maintenance, routine inspection, and service procedures shall also be included. All safety requirements and safety procedures shall be identified.
 - 2. Manufacturer to provide four sessions of training, for operation, maintenance, and instrumentation groups. The training shall be scheduled with OWNER a minimum of 10 days after an approved O&M manual and outline of training.

HIGH SPEED TURBO BLOWER SCHEDULE
DESIGN CONDITIONS AND PERFORMANCE REQUIREMENTS

Number to be supplied: 3	Location: Flint, MI
Design relative humidity (%): 60%	Elevation above sea level (ft.): 715 ft

A. Blower Capacity Criteria

Inlet air temperature (°F):	100 deg F
Barometric pressure	14.3 psia
Pressure at the blower inlet flange (psia):	14.2 psia
Rated pressure at the blower discharge flange (psia):	7.6 psig
Rated air flow per blower (Standard Cubic Feet per Minute SCFM):	16,000 SCFM

B. Motor Sizing Criteria

Inlet air temperature (°F) :	104 deg F
Pressure at the blower inlet flange (psia):	14.2 psia
Rated pressure at the blower discharge flange (psia):	7.6 psig
Max Unit Combined Motor horsepower:	700 hp

C. General Criteria

Inlet air temperature (°F): (range)	100 to -22 deg F
Pressure at the blower inlet flange (psia): (range)	14.2 to 14.4 psia
Minimum air flow (SCFM):	8,000 SCFM w/ both internal cores operating.

D. Blower Evaluation Criteria

Barometric pressure	14.3 psia
Pressure at the blower inlet flange (psia):	14.2 psia
Rated pressure at the blower discharge flange (psia):	7.6 psig

GUARANTEED PERFORMANCE REQUIREMENT SCHEDULE

Design Point	Capacity %	Flow scfm	Discharge Pressure psig	Inlet Temp ° F	RH %	Guaranteed Max Power HP
1	100.0%	16,000	7.6	50°	60%	725
2	70.0%	11,200	7.5	50°	60%	480
3	55.0%	8,800	7.5	50°	60%	390
4	45.0%	7,200	7.5	50°	60%	320

END OF SECTION

SECTION 11375 - FINE BUBBLE AIR DIFFUSION EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, including Section 01600, apply to Work of this Section.

1.02 REFERENCES

- A. Reference Standards:
 - 1. ANSI B-16.1 Pipe Flanges.
 - 2. ASTM A 240 Stainless Steel Pipe Supports.
 - 3. ASTM A 774 Stainless Steel Pipe.
 - 4. ASTM A 778 Stainless Steel Pipe Fittings.
 - 5. ASTM D 2564 PVC Pipe.
 - 6. ASTM D 2855 PVC Pipe.
 - 7. ASTM D 3034 PVC Pipe.
 - 8. ASTM D 3915 PVC Pipe.
 - 9. AWWA C-504 Butterfly Valves.

1.03 DEFINITIONS

- A. "Oxygen Transfer" shall be defined as the pounds of oxygen absorbed per day per 1,000 cubic feet of tank volume at standard conditions. Standard conditions shall be 20 degrees C, 760 mm mercury, 0.0 mg/l D.O. level, $\alpha = 1.0$, and $\beta = 1.0$.
- B. "Dynamic Wet Pressure" is defined as the pressure to operate at the specified conditions minus submergence and flow control losses.
- C. "Diffuser Headloss" is defined as the headloss from the pod through the diffuser to the water.
- D. "Orifice Loss" is defined as the headloss from the centerline of the header through the metering orifice and into the pod or element holder.

1.04 SYSTEM DESCRIPTION

- A. Design Conditions: Air supply equipment for this Project has been designed for actual in-waste oxygen transfer efficiency at the mid-operating range air flow rate per diffuser grid as listed on Schedule.
- B. Performance Requirements: The equipment shall provide a fine pore wastewater aeration system designed for full floor coverage of the aeration tanks using diffuser elements as specified under Article 2.02, Components.

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1.05 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. As-Constructed Drawings: Manufacturers shall furnish OWNER 4 sets of as-constructed Drawings.
- B. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.
- C. Oxygen Transfer: Prior to any shop testing, manufacturer shall submit to ENGINEER for approval, an outline of his test procedures including all formulas to be used in calculating oxygen transfer efficiencies.
 - 1. The results of the performance tests shall be submitted to ENGINEER in a written report. This report shall include all raw data sheets, plots, and calculations. In addition, all results shall be reported in a clear and concise manner, along with a written explanation of all pertinent information dealing with testing or analysis of the data.
 - 2. Manufacturer shall notify ENGINEER at least 1 month in advance of the scheduled test date in order that they may arrange for an observer and also an estimate of the time required to perform the tests.
- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- E. Equipment Data Sheet: Prior to the taking of Bids for this Contract, as noted on Data Sheet included in this Section, manufacturer of the equipment furnished under this Section shall furnish ENGINEER the information listed on Equipment Data Sheets. The purpose of the Data Sheets is to furnish OWNER necessary information so that an evaluation of the equipment can be accomplished.
- F. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.06 QUALITY ASSURANCE

- A. Oxygen Transfer: Certified documentation will be required to be submitted to ENGINEER.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Membrane Aeration Equipment:
 - a. Aquarius Technologies
 - b. EDI
 - c. ITT / [Sanitaire](#).
 - d. SSI

2.02 COMPONENTS

- A. The system shall include the vertical drop pipes, manifolds, air distribution headers, diffuser assemblies, supports, expansion joints, diffuser pressure monitoring panels, and appurtenant equipment necessary for a complete operating system. Diffuser layout shall provide a full-floor coverage capable of providing uniform air dispersion per unit area.
 - 1. The system shall be furnished with a hydrogen chloride gas cleaning system as specified and shown on Drawings.
- B. Drop Pipes: Existing portion of stainless steel drop pipe may be reused to connect to diffuser manifold. The drop pipe is believed to be Schedule 5S, Type 304L stainless steel in accordance with ASTM Standard A 778. Fittings shall be in accordance with ASTM Standard A 774 and be equal in wall thickness to the pipe.
 - 1. All fastening hardware shall be series 18-8 stainless steel. All connections shall be made using 125-pound drilled flanges. Flange bolts shall be Type 304 stainless steel with brass or bronze nuts.
- C. Manifolds: A manifold pipe shall be furnished and installed for each grid area that extends the full width of the aeration tank. The manifold pipe and fittings shall be SDR 26, PVC conforming to ASTM 3034 and 3915.
- D. Air Distribution Headers: Air distribution headers shall be furnished and installed with a spacing that provides uniform air dispersion per unit area. The header pipe and fittings shall be SDR 33.5, PVC conforming to ASTM 3034 and 3915.
 - 1. Design the diffuser grid layout to satisfy the following minimum requirements:
 - a. Minimum clearance of 12-inches from any wall to edge of diffuser.
 - b. Maximum clearance of 36-inches from any wall to edge of diffuser.
 - c. A minimum clear space of 1-inch between adjacent diffusers on the same header.
 - d. A maximum clear spacing of 36-inches between adjacent diffusers on same headers.
 - e. A minimum clear space of 6-inch between adjacent diffusers on adjacent headers.
 - f. A maximum clear spacing of 36-inches between adjacent diffusers on adjacent headers.
 - g. A minimum clear spacing of 10-inches from bottom of tank to diffusers.
 - 2. Each diffuser grid shall be provided with at least 1 moisture purge connection. The moisture purge shall consist of a 3/4-inch PVC blowoff line terminating at least 18 inches above the basin water level with a 3/4-inch PVC ball valve. The blowoff line shall connect to a sump in the air piping which shall collect condensate or water which enters through the diffusers when power is off. The sump bottom shall be below the bottom elevation of the distribution headers. Provide a 1-inch diameter flexible connection where the moisture blowoff line connects to the header system.
- E. Membrane Diffuser Assemblies: Diffuser assemblies shall consist of round rubber membrane diffusers, diffuser element holders, diffuser element retaining device(s), and airflow control orifices.
 - 1. Diffuser element holders shall be PVC, polypropylene, or polyamide plastic, formed to support the diffuser when the air supply is interrupted and hold the diffuser firmly in position during operation. Diffuser element holders shall be securely attached to the header pipe, and shall provide means for fastening the diffuser membrane in a fashion which precludes the possibility of it coming loose.

2. Rubber membrane diffusers shall be fabricated from an EPDM rubber compound formulated by the manufacturer specifically for use in air diffusers to be used in wastewater aeration. Perforations for air discharge may be round holes or slits, formed by piercing the membrane using methods which do not result in removal of any material to create the perforations. Hole/slit size shall be determined by manufacturer to optimize oxygen transfer efficiency, and minimize the potential for air side fouling.
 3. Membrane thickness shall be determined by manufacturer who shall certify that, if operated at air flow rates less than a manufacturer-stipulated maximum, the diffuser membrane will not experience permanent deformation (elongation) or tearing at the air flow perforations for a period of 5 years.
 4. Diffuser membranes shall be retained by removable corrosion-resistant devices of PVC or stainless steel construction which hold the entire edge of the membrane securely in place. Intermittent clips or clamps shall not be acceptable.
- F. Diffuser Pressure Monitoring Panels: Each diffuser grid shall be furnished with a monitoring panel box, support brackets, polyethylene tubing, PVC carrier pipe, and fittings to monitor air distribution header pressure, diffuser element holder plenum pressure, and submergence pressure.
1. Three diffusers in each grid shall be instrumented to monitor diffuser headloss and orifice losses. The 3 diffusers to be monitored shall be selected by ENGINEER, and may be located anywhere in the grid.
 2. The monitoring panel shall be of fiberglass construction, made watertight with a continuous gasket along the sealing face of the panel door. The panel door shall be provided with a 1/4-turn handle and piano hinge. Panel support shall be as shown on Drawings.
 3. Pressure sensing lines shall be polyethylene tubing with polypropylene fittings. Each sensing line shall be provided with a PVC ball valve and quick coupling connection compatible with the portable gas cleaning mounting panel. The submergence pressure bubbler tube shall be 1/2-inch diameter, and other sensing lines shall be 3/8-inch diameter. Sensing lines shall be housed in a 1-1/2-inch diameter Schedule 80 PVC carrier pipe. The carrier pipe shall be supported from the drop pipe using stainless steel angles, U-bolts, and fastening hardware. Each panel shall be equipped with polypropylene quick disconnect fittings for connection to the portable monitoring panel to each grid.

2.03 ACCESSORIES

- A. Spare Parts: The aeration equipment manufacturer shall supply the following spare parts:
1. 50 each membrane diffusers.
 2. 50 each O-rings or gaskets.
 3. 15 each diffuser hold-down rings.
 4. 4 each lengths of diffuser header piping with the diffuser connector spacings at the minimum spacing used on the project (length similar to average length used).
 5. 4 each Header expansion fittings.
- B. Supports: Manifold and header supports shall be designed to withstand pipe bouyant forces with a 2.0 factor of safety. Support spacings shall not exceed 8'-0" and supports shall be provided at the ends of all pipework.
1. All pipe supports shall be designed to provide 2-inch vertical and 1/2-inch horizontal adjustment for field alignment of the piping system.
 2. Manifold and header pipe supports shall be Type 304 stainless steel. Supports shall be fastened to the aeration tank floor using stainless steel expansion anchors designed to withstand applied pull-out forces with a 4.0 factor of safety. Expansion anchors shall have 3-inch embedment

minimum. Fixed and guide supports shall be provided and arranged to be compatible with expansion joint installation. Fixed header supports shall consist of a 1-1/2-inch-wide hold-down clamp contoured to the pipe perimeter. The clamping device shall positively grip the air distribution header when tight and be self-limiting to prevent over-stressing of the air header if the clamp is over-tightened. Guide supports shall consist of a 2-inch-wide guide strap for the manifolds and a 1-1/2-inch-wide guide strap for the headers contoured to the pipe perimeter. The guide clamp edges shall be chamfered to avoid binding between the pipe and guide clamp. A sliding surface shall be provided between the clamp and pipe to minimize resistance to movement. A 1/8-inch clearance shall be provided between the sliding surface and the pipe. A self-limiting feature shall be provided to maintain the specified clearance if the clamp is over-tightened.

- C. Expansion Joints: PVC expansion joints shall be provided on the air distribution headers at intervals to accommodate thermally induced stresses due to expansion and contraction. Expansion joints shall be airtight and permit force movement of the header plain end within the joint barrel. The expansion joint seal shall be by an O-ring gasket made from polyisoprene. The O-ring shall be held in place by a threaded retainer ring. The expansion joint shall be designed for a 4-inch minimum stroke with an average 50-pound operating force or design calculations and details shall be provided to allow travel for a 125 degrees F temperature change. The number and location of expansion joints in each diffuser grid shall be as recommended by manufacturer and approved by ENGINEER. A preliminary layout of expansion joints shall be included with the Equipment Data Sheet.
- D. Portable Monitoring Panel: A portable monitoring panel shall be provided for connection to the diffuser pressure monitoring panels. The portable panel shall contain a vapor actuated differential pressure gauge with 3-1/2-inch face and 0 - 30-inch w.c. range suitable for outdoor exposure; a 0 - 5 scfh rotameter; and isolation valves and polyethylene tubing for connection to the fittings in the diffuser pressure monitoring panels.
 - 1. The portable panel shall be arranged as shown on Drawings so that the differential pressure gauge can measure pressure drop between the air header and the diffuser plenum, between the air header and the bubbler, and between the diffuser plenum and the bubbler. The rotameter shall measure airflow to the submergence bubbler.

2.04 FABRICATION

- A. System: Air diffusion system shall not be fabricated until ENGINEER has approved the oxygen transfer test results.
- B. Pipe and Fittings: The PVC resin used for all pipe and fittings shall be treated for ultraviolet light exposure by adding 2 parts (by weight) of titanium dioxide per 100 parts of resin.
- C. Drop Pipes: All welding shall be completed at the point of fabrication using the shielded arc or inert gas method. Where filler wire is used, it shall be the same material as the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint. Weld beads shall be smooth and evenly distributed with an interior projection not exceeding 1/16 inch beyond the pipe or fitting I.D. Face ring angles and follower flanges shall be continuously welded, both sides.
 - 1. Weld splatter shall be removed using a stainless steel wire brush. Fabricated assemblies shall be completely immersed in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid to remove carbon deposits, grease, and oils. Following the pickling process, the assembly

shall be neutralized by immersion in a tri-sodium phosphate rinse to regenerate a uniform, chromium oxide film.

- D. Manifolds: The manifolds shall be fabricated with 4-inch-diameter flanged stubs for connection to the distribution headers. Connections to the manifold shall be reinforced with solvent-welded saddle tees.
 - 1. All joints shall be factory solvent welded in accordance with ASTM D 2855. Solvent cements shall be suitable for use with PVC and conform to ASTM D 2564 requirements.
- E. Air Distribution Headers: The distribution headers shall be fabricated with the diffuser element holder factory solvent welded to the crown of the header. Diffuser element holders shall be attached so that they can resist the following applied torques:
 - 1. About the holder polar axis 150 foot-pounds.
 - 2. About the holder longitudinal axis 100 foot-pounds.
 - 3. Distribution headers shall be fabricated in sections not to exceed 20 feet in length. Sections of distribution headers shall be connected with joints as specified herein.
- F. Diffuser Element Holder: All diffuser element holder joints shall be factory solvent welded in accordance with ASTM D 2855. Solvent cements shall be suitable for use with PVC and shall conform to ASTM D 2564 requirements.
- G. Supports: Pipe supports, including supports for moisture purge lines, shall be fabricated from Type 304L stainless steel for welded assemblies and Type 304 stainless steel for nonwelded parts. Materials shall conform to ASTM A 240-78. All welding shall be completed at the point of fabrication using shielded arc or inert gas methods. All welds shall be stainless steel wire brushed. Fabricated assemblies shall be immersed in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid. Following the pickling solution, the fabricated assembly shall be immersed in a tri-sodium phosphate solution to regenerate a uniform chromium oxide corrosion-resistant film.
- H. Expansion Joints: The expansion joint barrel shall be factory solvent welded to one end of the distribution header.

2.05 SOURCE QUALITY CONTROL

- A. Testing: Where noted on Schedule, aeration equipment manufacturer shall conduct factory tests of the equipment to demonstrate its capability to achieve the specified oxygen transfer and head loss requirements at the specified conditions. The tests shall be conducted at aeration equipment manufacturer's facility, as a condition of acceptance prior to fabrication of the air diffusion system. Testing shall be done in conformance with the ASCE Standard for Measurement of Oxygen Transfer in Clean Water, 1984.
 - 1. If the equipment does not meet the guaranteed oxygen transfer efficiency or the guaranteed headloss as demonstrated by shop testing, the equipment shall be rejected by ENGINEER.
- B. Diffuser Assemblies: Diffuser elements shall be tested by submerging the unit in at least 2 inches of tap water.
 - 1. Manufacturer shall randomly select diffuser elements from each lot manufactured for testing. The number tested shall be in accordance with Military Standard 105D, Table I, Inspection Level II or 0.2 percent, whichever is greater. These diffuser elements shall be tested for specific permeability, hydrostatic load, dynamic wet pressure, and dimensional tolerances. Tested diffuser elements shall be marked for identification. A test report shall be submitted to

- ENGINEER summarizing the test procedures and results. The sampling results shall demonstrate a value of percent defective of less than 1.5 percent of the total units furnished.
2. Equipment manufacturer shall test diffuser assemblies similar to those to be furnished.

PART 3 - EXECUTION

3.01 ERECTION

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

3.02 EXAMINATION

- A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the equipment once prior to installation to review installation procedures with CONTRACTOR, and once after installation to inspect, check, adjust if necessary, and approve equipment's installation.
 1. Manufacturer shall provide the services of a factory-trained representative to instruct OWNER's personnel in all aspects of system operation and maintenance. Such instruction shall take place immediately after system start-up. Manufacturer shall allow for 3 trips to the Site and a total of 6 person-days to account for the above-stated installation checks.

3.03 ERECTION, INSTALLATION AND APPLICATION

- A. Supports: After pipe installation, the tank shall be filled with water to the level of the diffuser element holders. Header pipe supports shall be adjusted so that diffuser elements are level within plus or minus 1/4 inch. The air shall be turned on with the diffuser elements off, and the headers blown out and cleaned prior to diffuser element installation.

3.04 FIELD QUALITY CONTROL

- A. Tests: Where noted on Schedule, equipment manufacturer shall conduct on-site mixing tests of the equipment to demonstrate its capability to maintain uniform suspension of tank contents.
- B. Expansion Anchors: All expansion anchors shall be field tested following installation to verify their pull-out resistance. Anchors that fail to meet the pull-out test shall be replaced or supplemented by additional anchors.

3.05 DEMONSTRATION

- A. Training: Where herein specified, manufacturer shall provide the services of a factory-trained representative to instruct OWNER's personnel.

MEMBRANE FINE BUBBLE AERATION EQUIPMENT
EQUIPMENT DATA SHEET

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The manufacturer of this equipment shall submit to ENGINEER, 72 hours prior to the Bid date, the following specific data on the equipment being offered. The purpose of this information is to provide OWNER the information necessary to evaluate the equipment. Failure by a manufacturer to furnish all the information requested shall be cause for rejection of the equipment. Any exceptions to these Specifications must be noted and included with the information submitted with this form. Exceptions may be cause for rejection of the equipment. A minimum of 1 week prior to the taking of Bids on this Contract, manufacturers will be advised whether their equipment has been approved, and an Addendum will be issued listing the names of all approved equipment manufacturers and the total number of diffusers each will be required to provide. Equipment manufactured by manufacturers not listed shall not be acceptable. Exceptions to the Specifications, unless specifically addressed in the Addendum, are not approved.

A. DYNAMIC WET PRESSURE

List the dynamic wet pressure of a clean, new, individual diffuser in tap water at the listed airflow rates:

Dynamic wet pressure is the total pressure required at the listed airflow for a diffuser submerged a minimum of 2-inches, minus submergence and distribution orifice losses.

B. PERMEABILITY

List the dry permeability of a clean, new diffuser at the listed airflow rates.

Permeability is the airflow rate in scfm per square foot of diffuser surface area at a pressure differential of 2-inches water column.

C. CLEAN WATER OXYGEN TRANSFER EFFICIENCY

List the non-steady-state oxygen transfer efficiency of a diffuser grid in tap water at 20 degrees C, 14.7 psia, and 0.0 mg/l D.O. at the indicated air flow rates per diffuser, at a diffuser submergence of 12'-2". Attach supporting test data.

D. IN-WASTE OXYGEN TRANSFER EFFICIENCY

List the steady-state oxygen transfer efficiency of a diffuser grid in mixed liquor (in a functioning aeration tank) corrected to standard conditions of 20 degrees C, 14.7 psia, and 0.0 mg/l mixed liquor D.O. at the indicated air flow rates per diffuser, adjusted to a diffuser submergence of 12'-2". Attach supporting test data and a detailed description of test procedures and the test location with wastewater parameters. Test data and procedures for in-waste testing conducted by Tetra Tech MPS need not be submitted

(continued)

Air Flow per Diffuser	A. DWP (in w.c)	B. Permeability (scfm/sf)	C. Clean Water OTE %	D. In-Waste OTE%
0.5 scfm				
1.0 scfm				
1.5 scfm				
2.0 scfm				
2.5 scfm				
3.0 scfm				

E. ASSEMBLY

Attach a detailed arrangement drawing for one complete drop assembly, complete, including quick disconnect coupling, riser pipe, header, diffuser assembly, adjustable support legs, details and locations of expansion joints, and junction box. Indicate all pipe diameters, materials, thickeners (Schedule, SDR, etc.), etc.

F. PERFORMANCE GUARANTEE

The aeration equipment manufacturer guarantees the clean water oxygen transfer efficiency (Item C) of the equipment configuration he proposes to furnish. Number of drops, submergence and riser and header pipe sizes shall be as shown on Drawings.

G. INSTALLATION DATA

Attach a list of five installations where the proposed air diffusion equipment has been installed and operated in a municipal wastewater treatment facility. State number of diffusers installed, treatment capacity of the plant in mgd, contact person name, address, and telephone number.

By: _____

Representing: _____

Telephone: _____

Date: _____

FINE BUBBLE AIR DIFFUSION EQUIPMENT SCHEDULE:

Type: 9-inch Diameter Membrane Diffuser

No. of Tanks: 1 tank, 4 passes

No. Drops per pass: 3 (existing)

Tank Dimensions

Length: 200'

Width: 24'

Depth: 15'

SWD: 13'

Submergence: 12'-2"

Actual Oxygen Requirement: 14,300 lbs/day/tank Max day

Required Dissolved Oxygen: 2.0 mg/L

Remarks: Existing Zone Information to match

Aeration Zones	No. of Grids	No. of Headers	Min. No. of Diffusers
1	1	8	480
2	1	7	320
3	1	7	250
4	1	8	480
5	1	7	320
6	1	7	250
7	1	7	175
8	1	7	150
9	1	7	150
10	1	7	150
11	1	7	150
12	1	7	150

END OF SECTION

SECTION 11376 - COMPRESSED GAS MIXING SYSTEM

PART 1 – GENERAL

1.01 SCOPE

- A. General: Furnish, install and test packaged compressed air mixing system.
- B. This section covers the furnishing of a compressed gas mixing system for the Battery B Aeration Basins (Pass 4) and Channels including compressors, receivers, master control panel, remote I/O panel, valve modules, header supply piping, nozzle headers, nozzles, auxiliary equipment and accessories as specified herein and shown on Contract Drawings.
- C. The system design is based on Enviromix (Basis of Design). The mixing system is integral to the operation of the existing aeration tanks and channels. Approval by ENGINEER is required for any proposed deviations from the basis of design.
- D. Refer to system configuration drawing sheet I-100 for requirements on PLC hardware, panelview and ethernet switch information. Manufacturer responsible for providing IO cards as required to suit the process equipment being provided. PLC hardware to be Rockwell. Provide Rockwell panelviews- model as noted. Ethernet switches to be Hirschman- model as noted on drawings
- E. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section as shown on Drawings or listed on Schedule.

1.02 DESCRIPTION

- A. The system shall intermittently and sequentially inject compressed air through fixed nozzles located on the basin floor to create large bubbles which effectively mix the basin contents using no moving parts located within the basin with negligible oxygen transfer from the mixing system to the bulk liquid.
- B. Manufacturer shall meet the performance requirement to maintain a mixed system.

1.03 REFERENCES

- A. ASTM International (ASTM)
 - 1. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
 - 2. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - 3. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe
 - 4. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

1.04 DEFINITIONS

- A. Basin: The structure within which mixing occurs; i.e., Anoxic/Swing Zones, Channels, Aeration Tanks, Equalization Tank, etc.
- B. Main Air Header Pipe: Piping from compressor to valve modules.
- C. Header Supply Pipe: Piping between a valve module and respective nozzle headers.
- D. Nozzle Header: Continuous (i.e., not branched) horizontal piping with nozzle offsets, with single inlet connection to header supply pipe and outlet offset connections to nozzles.
- E. Nozzle Drop Leg: Piping branching off nozzle header trunk piping which connects to nozzles either at a 90-degree angle (offset drop leg) or vertically (straight drop leg).
- F. Nozzle: Floor-anchored, large bubble-emitting device.
- G. Standard Cubic Feet per Minute (scfm): Air at 68° F, 14.7 psia, and 0 percent relative humidity as defined by the Compressed Air & Gas Institute.
- H. Actual Cubic Feet per Minute (acfm): Flow rate of air at the standardized reference condition (ISO 1217) delivered to the terminal point of the compressor package.
- I. Master Control Panel (MCP): Control panel that controls the mixing system including the solenoid-actuated air control valves (ACVs) in one or more remote VMs.
- J. Valve Module (ZVM): Enclosure with solenoid-actuated air control valves controlled remotely by the MCP controller or locally factory programmed controller. Valves are in a common manifold which receives and distributes compressed air bursts intermittently to header supply pipes.

1.05 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings:
 - 1. Catalog data or illustrations showing principal parts and materials.
 - 2. A complete set of all layout drawings and details including complete assembly and installation drawings including overall equipment layout and piping interconnection drawings.
 - 3. Complete electrical schematics and field termination drawings.
 - 4. Complete data for accessory items.
 - 5. Detailed specifications and data including the following:
 - a. Compressors
 - 1) Manufacturer
 - 2) Type and model
 - 3) Rotative speed
 - 4) Dimensions
 - 5) Weight including motor
 - 6) Performance data
 - 7) Bearing data
 - 8) Separator details
 - 9) Filter details

- 10) Accessory details
- 11) Piping schematic
- 12) Control equipment
- 13) Sequence of operation
- b. Motors
 - 1) Manufacturer
 - 2) Type and model
 - 3) Horsepower rating and service factor
 - 4) Insulation class
 - 5) Temperature rise full load
 - 6) Rotative speed
- c. Particulate and Coalescing Filters, as applicable
 - 1) Manufacturer
 - 2) Type and model
 - 3) Pressure drop
- 6. Test or performance data that the system does not contribute measurable oxygen into the process stream.
- 7. Compressor support locations and loads transmitted to bases and foundations.
- 8. Compressor electrical schematics and field termination wiring.
- 9. List of recommended spare parts.
- 10. Qualifications of field service engineer.
- 11. Recommendations for short and long-term storage.
- 12. Special tool requirements.
- 13. Testing procedures.
- 14. Full scale test results from a minimum of ten (10) U.S. compressed gas mixing system installations demonstrating that the compressed gas mixing system achieved homogeneous mixing as substantiated through statistical analysis of Total Suspended Solids (TSS) samples yielding a Coefficient of Variation (Cv) of 10%.
- 15. Installation reference of not less than ten (10) separate North American installations of compressed air mixing systems similar to that required for the Project in satisfactory operation for at least two (2) years and not less than five (5) separate North American installations of compressed air mixing systems with nozzle quantity not less than required for this Project. Installations shall be where the Manufacturer supplied compressors, receivers, control panels, header supply piping, nozzle headers and nozzles. For each installation, submit the following information: name of facility owner, facility name, facility location including city and state, facility operation and maintenance contact person including name and telephone number, equipment model number and motor size, nozzle quantity, and month and year that equipment was placed into continuous service.

1.06 WARRANTY

- A. The Compressed Gas Mixing Manufacturer shall guarantee the equipment against defects in materials and workmanship under normal use and service, to the original purchaser, for a period of twelve (12) months from date of equipment startup by an authorized technician or eighteen (18) months from date of equipment shipment, whichever is the lesser.
- B. Requirements to maintain the compressor warranty are:
 - 1. Factory Authorized start-up by a representative of the Compressor Manufacturer distributor/factory store.
 - 2. OEM filters and oil used at the intervals described in the compressor O&M manual.

3. Oil samples are to be taken and analyzed every 4,000 hours of run-time or as defined in compressor O&M manual or once a year.
4. Maintenance in accordance with compressor Manufacturer's operating and maintenance instruction.

1.07 QUALITY ASSURANCE

- A. The compressed gas mixing system shall be furnished by a single Manufacturer who has a minimum of ten (10) years' experience producing substantially similar equipment and shall have provided a minimum of five (5) individual systems of similar size of not less than the specified minimum quantity of nozzles for this Project in satisfactory operation for at least two (2) years.
- B. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods. The system manufactured by EnviroMix, Inc. of Charleston, SC, was utilized as the basis of design. Any substitutions shall be approved by ENGINEER.
- C. This specification includes patented technology under US Patents 6280636, 8505881, 8702070, 9416037.
- D. The Contractor shall obtain the compressors, receivers, control panels, header supply piping, nozzle headers, nozzles and appurtenances from the compressed gas mixing system Manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
- E. Alternate Manufacturer's wishing to offer their equipment must submit the following information to the Engineer in a Pre-Qualification Package within fourteen (14) days prior to the published date of Bid Closing. Engineer will evaluate information and if in the Engineer's sole discretion, the Alternate Manufacturer's proposed compressed gas mixing system meets the specification, performance and offers equal quality and experience to the basis of design, the Alternate Manufacturer will be added to the compressed gas mixing specification via addendum.
 1. A complete set of drawings, specifications, catalogue cut sheets, and detailed descriptive material of proposed major equipment items. This information shall identify all technical and performance requirements stipulated on each drawing and in each specification section.
 2. Full scale test results from a minimum of ten (10) U.S. installations demonstrating that the compressed gas mixing system achieved homogeneous mixing as substantiated through statistical analysis of Total Suspended Solids (TSS) samples yielding a Coefficient of Variation (Cv) of 10% or less at nozzle densities +/- 10% of the density specified for this project.
 3. Test or performance data that the compressed gas mixing system does not contribute measurable oxygen into the process stream.
 4. Full scale test results from a minimum of two (2) U.S. installations demonstrating that the compressed gas mixing system does not negatively impact biological nitrogen and/or phosphorus removal.
 5. Written confirmation from Authorized Officer of the Company that the proposed compressed gas mixing system includes complete Unit Responsibility with all components specified in Section 46 41 26 – Compressed Gas Mixing System as well as the specified Field Performance Testing and Guarantee.

6. Installation reference list including a minimum of ten (10) U.S. compressed gas mixing installations for which the supplier furnished and integrated the complete compressed gas mixing system, including compressors, receivers, control panels, header supply piping, nozzle headers and nozzles. Provide facility name/location, design average daily flow, contact name/telephone number and start-up date for each installation.
 7. Installation reference of not less than ten (10) separate North American installations of compressed air mixing systems similar to that required for the Project in satisfactory operation for at least two (2) years and not less than five (5) separate North American installations of compressed air mixing systems with nozzle quantity not less than required for this Project.
 8. List of recommended spare parts.
 9. Equipment field installation requirements.
 10. A maintenance schedule with projected labor hours showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period.
 11. Reviewed specification with each paragraph marked noting full compliance and detailed written documentation with discussion of all deviations from the specification.
 12. Letter from a Surety indicating that the Manufacturer is pre-approved to receive a two (2) year performance bond.
- F. Should the Contractor choose equipment from a Manufacturer of an acceptable equivalent product, any additional costs required to accommodate such equipment, including any changes to the field air piping, power distribution or additional Engineer review time, shall be made without a change in the Contract Price or Contract Time and at no additional cost to the Owner
- G. A performance bond from the Manufacturer guaranteeing the replacement of the acceptable equivalent product shall be provided with the submittal package. The bond term shall be for a period of two (2) years. If the operation of the acceptable equivalent compressed gas mixing system as determined by the Owner is unsatisfactory, the Contractor shall repair, modify or replace the entire system to include the compressed air equipment system with appurtenances, in a manner acceptable to the Owner. If the Contractor fails to correct deficiencies identified by the Owner within six (6) months of the date first notified in writing, the Owner shall, at its own discretion make all necessary repairs or replacement and deduct all associated costs from the performance bond.

PART 2 – PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Provide a compressed gas mixing system for the Battery B Aeration Basins (Pass 4) and Channels. The system shall intermittently and sequentially inject compressed air through fixed nozzles located on the basin floor to create large bubbles which mix the basin contents using no moving parts located within the basin with negligible oxygen transfer from the mixing system to the bulk liquid.
- B. Basin mixing shall be uniform throughout the basin with effective mixing confirmed through a Field Performance Test as specified.

- C. Mixing intensity and balancing shall be sufficient to maintain suspended solids in a state of suspension over entire basin. The operator shall control firing parameters (sequence, duration, and frequency) to achieve basin mixing.
- D. Firing air flow rate shall be adjustable via the throttling valve.
- E. The compressed gas mixing system equipment and piping shall be sized to thoroughly mix the contents of the basins for which the systems are designed.
- F. Treatment Processes

Battery B Aeration

Basin	Aeration - Pass 4
Basin Length (ft.)	200
Basin Width (ft.)	24
Basin Side Water Depth (ft.)	13
Number of Basins	5
Number of ZVMs	5
Number of ACVs per ZVM	6
Number of Nozzle Headers	30
Number of Nozzles per Nozzle Header	10
Minimum Total # of Nozzles	300
Minimum Nozzle Header Dia. (in.)	2.0

Primary Influent and Battery A Channels

Basin	Primary Influent	Aeration Influent	Aeration Effluent	Secondary Clarifier Influent
Basin Length (ft.)	523	425	377	140
Basin Width (ft.)	6.5	6	10	6
Basin Side Water Depth (ft.)	4.5	9	9	9
Number of Basins	1	1	1	1
Number of ZVMs per Basin	1	1		
Number of ACVs per ZVM	8	14		
Number of Nozzle Headers	8	6	5	3
Number of Nozzles per Nozzle Header	13	12	13	9
Minimum Total # of Nozzles	103	72	65	22
Minimum Nozzle Header Dia. (in.)	2.0	2.0	2.0	2.0

Battery B Channels

Basin	Aeration Influent	Aeration Effluent Section 1	Aeration Effluent Section 2	Aeration Effluent Section 3	Secondary Clarifier Influent
Basin Length (ft.)	466	400	295	240	164
Basin Width (ft.)	9	10	10	10	10
Basin Side Water Depth (ft.)	4.5	9	9	9	9
Number of Basins	1	1	1	1	1
Number of ZVMs	1		1	1	
Number of ACVs per ZVM	13		4	5	
Number of Nozzle Headers	7	6	4	3	2
Number of Nozzles per Nozzle Header	14	12	12	13	14
Minimum Total # of Nozzles	98	72	48	39	28
Minimum Nozzle Header Dia. (in.)	2.0	2.0	2.0	2.0	2.0

G. Performance Requirements

- The compressed gas mixing system Manufacturer shall be responsible for sizing and selecting all system components to meet the requirements of the field mixing performance test specified herein. The compressor size, number of nozzles and piping size specified herein and shown on the Drawing are minimum. Any increase in the number and size of system components to meet the requirements of the field mixing performance test shall be at no additional cost to the Owner.

2.02 MATERIALS

A. Main Air Header Supply Piping

- The main air header supply piping from compressors to Valve modules shall be furnished and installed by CONTRACTOR.
- Sch 5S, stainless steel Press technology system (Viega, or equal), comprised of stainless steel Press technology fittings, couplings, and pipe, unless specified otherwise. Per the requirements of Section 15105 and 15212.
- Maximum working pressure of 150 psi.
- Couplings and fittings: Press technology products formed of Type 304/304L stainless steel tubing including a self-contained o-ring seal(s) molded of synthetic FKM rubber.
- Pipe: Type 304/304L ASTM A312 stainless steel.

B. Header Supply Piping

- Provide threaded connections only where required.
- Sch 5S, stainless steel Press technology system (Viega, or equal), comprised of stainless steel Press technology fittings, couplings, and pipe, unless specified otherwise.
- Maximum working pressure of 150 psi.
- Couplings and fittings: Press technology products formed of Type 304/304L stainless steel tubing including a self-contained o-ring seal(s) molded of synthetic FKM rubber.
- Pipe: Type 304/304L ASTM A312 stainless steel.

C. Nozzle Headers

- Sch 10S, 304/304L stainless steel with 1" Sch 40S, stainless steel nozzle offsets

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2. Nozzle couplings: 1" NPT, 150 lb, 304/304L stainless steel
3. Delivered from the Manufacturer pre-assembled to the extent practicable to minimize field assembly error and installation time.
4. Pipe: Type 304/304L ASTM A312 stainless steel.
5. Provide nozzle headers in maximum 20-ft segments with two bolt 304/304L stainless steel flexible gasketed coupling connections. Flexible couplings shall be rated for a maximum working pressure of 150 psi.
6. Provide nozzle headers with removable end caps to facilitate clean-out.

D. Nozzles

1. Top plate fabricated from 1/8" stainless steel plate, ASTM A240/A240M, Type 304/304L with a 2D finish.
2. Bottom plate fabricated from HDPE and gasketed to prevent air from leaking between the top plate and the bottom plate.
3. Top and bottom nozzle plates shall be joined together using Type 304/304L stainless steel hardware. Nozzles shall come pre-assembled.
4. Nozzles shall be designed with adequate strength to withstand vertical thrust of mixing air.
5. Threaded Rod Anchors: Use Hilti HIT-RE 500 adhesive or equal to be provided by the Contractor. A minimum of two threaded rods shall be installed per nozzle for flat floor installations, one each on opposite diagonal corners. Three threaded rods shall be installed per nozzle for slope floor installations.
6. Nozzles shall be installed in the locations as shown on the Drawings.

E. Appurtenances

1. Miscellaneous: Nuts, bolts, washers, threaded rod, and other non-welded parts shall be stainless steel, ASTM A240/A240M, Type 304. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

F. Fabrication

1. The piping used for the air mixing system shall be Type 304/304L stainless steel unless otherwise noted.
2. Shop fabricate welded metal parts and assemblies from stainless steel, ASTM A240/A240M, Type 304/304L with a 2D finish.
3. Shop fabricate non-welded parts and pieces from sheets and plates of stainless steel, ASTM A240/A240M, Type 304 or from bars of stainless steel ASTM A276, Type 304, unless specified otherwise.
4. Welds and Welding Procedure
 - a. Shop weld with filler wire using MIG, TIG or shield-arc, or plasma-arc welding inert gas processes. Provide a cross-section equal to or greater than parent metal.
 - b. Provide full penetration welds to interior surface with gas shielding to interior and exterior of joint.
 - c. Provide smooth, evenly distributed interior weld beads with an interior projection not exceeding 1/16 inch beyond inner diameter of nozzle header or fittings.
 - d. Field welding is not permitted.
 - e. Clean all welded stainless steel surfaces and welds after fabrication to remove weld splatter and finish clean all exterior welds, carbon deposits and contaminants by passivation per ASTM A380 Section 6.2.11.

2.03 MASTER CONTROL PANEL (MCP)

A. General Requirements

1. Refer to system configuration drawing sheet I-100 for requirements on PLC hardware, panelview and ethernet switch information. Manufacturer responsible for providing IO cards as required to suit the process equipment being provided. PLC hardware to be Rockwell. Provide Rockwell panelviews- model as noted. Ethernet switches to be Hirschman- model as noted on drawings.
2. Coordinate IP addresses with Owner.
3. PLC logic and panelview graphics shall conform to the owners existing software programming standards. Coordinate with Owner prior to programming of these manufacturer supplied systems.
4. Furnish to owner actual electronic program copies of the PLC programs and the panelview applications. These applications shall be integrated to the existing plant-wide SCADA system by Tetra Tech.
5. Coordinate with Tetra Tech on any signals needed from the existing plant wide SCADA system for automatic operation of the manufacturer supplied systems. These signals will be messaged over the plant wide fiber optic/SCADA network.
6. Panelview applications to have at a minimum 3 levels of password security. Coordinate exact requirements with Tetra Tech.
7. PLC's panelview's, and switches to be powered by an on-line UPS. Provide bypass contactor for bypassing the UPS in the event of a failure.
8. Panels to be provided with input surge protection.
9. Panels to be provided with step-down transformers externally mounted as required.
10. The panelview programming shall include at a minimum software manual operation of the equipment from the panelview. Software automatic operation shall be provided as specified herein and as coordinated with Owner/Tetra Tech.
11. Furnish fiber optic patch panels as show on instrumentation drawings.
12. Furnish ethernet patch cables as shown. Furnish duplex multimode fiber optic patch cables- 50 micron as shown. Connectors as noted on drawings.

B. Wall Mount or Free Standing Enclosure: MCP shall have UL-rated NEMA 4 painted steel enclosure and be rated for a maximum ambient temperature of 104°F.

C. Power Connection: MCP shall accept a single source 120 VAC power connection. Lightning and surge protection shall be provided on the incoming line power.

D. Operator Interface Terminal (OIT): The MCP shall have an OIT to make operating parameter changes and acknowledge alarms. The OIT shall be an Allen Bradley 10" Panelview Plus 7 color touchscreen. The OIT shall have flash memory capacity, USB port, and Ethernet communication.

E. Controller: MCP shall be equipped with an Allen Bradley CompactLogix 5069-L306ER controller which controls the mixing system including sequence, duration, and frequency of the air control valve (ACV) openings in each valve module (VM). The controller shall also provide network communication capabilities via Ethernet IP protocol.

- F. Ethernet Switch: MCP shall include a Hirschmann Model RS20-0800M2M2SAE Ethernet switch.
- G. Nameplate: A stainless steel nameplate shall be provided on the control panel. The nameplate shall be securely fastened in a conspicuous place and clearly inscribed with the Manufacturer's name, year of manufacture, and serial number.
- H. Control and Operation
1. Control Features: All control features shall be adjustable from the OIT provided by the mixing system Manufacturer. Control features shall be adjustable at any time during the operation of the system. Control features shall be initially set according to Manufacturer recommendations.
 2. Mixing Parameters: The operator shall be able to enable/disable mixing operation, select the firing sequence, the firing duration and the frequency of firing. Minimum control features selected through the OIT shall include the following:
 - a. Enable/Disable: ACV firing can be started and stopped at any point during operation without powering down the system.
 - b. Firing Sequence: Order and operation in which ACVs are fired, e.g. 1,2,3,..8 1,1,2,2,3,..8 8,1,7,2,..1.
 - c. Firing Duration: Length of time an individual ACV is open during a firing event. The duration shall be operator adjustable within programmed limits and configurable for each ACV individually.
 - d. Firing Frequency: Length of time to complete the firing sequence. Frequency shall be operator adjustable within programmed limits.
 - e. Valve Isolation: Individual ACVs or specific groups of ACVs may be added and/or removed from the firing sequence at any point during operation.
 3. High Intensity Mixing Cycle: The control system shall be equipped with an intermittent mode that mixes at a higher intensity for a short duration and cycles through each VM. This cycle can be enabled and the frequency and duration can be adjusted through the OIT.
 4. Preventative Maintenance Cycle: The control system shall be equipped with a special cycle that pulses the system during an extended mixing disabled period.
 5. Zone Control: VMs distributed across multiple tanks or zones shall be grouped into separately controlled zones that can be enabled independently.
 6. Alarms: VMs shall come equipped with a pressure transducer plumbed to the valve manifold. The pressure transducer shall transmit pressure anomalies to the controller. The controller shall interpret the pressure to provide a low system pressure alarm and monitor ACV position.
 7. Alarm Indication: When either the low system pressure or Valve Fail to Open alarms occur, a red general alarm light shall be illuminated on the MCP. The specific alarm shall be indicated on the OIT and shall remain until the fault is corrected or the system is turned off.
 8. Heartbeat Function: The controller shall have a register with a bit that toggles at a regular interval to act as a heartbeat for confirmation of continued controller operation and network communication.
 9. Compressors: The controller shall enable/disable compressors in a lead/lag sequence to maintain optimum system pressure based on the compressor discharge pressure transducer signal. The controller shall automatically rotate compressors for balanced runtime.
 10. Condensate Drain Valve Control: The controller shall open and close the condensate drain(s) based on operator adjustable frequency and duration settings.

11. Remote Communication with the Compressors and Compressor Line Pressure Transducer:
 - a. The controller shall communicate using the following I/O via hardwired conductors.
 - 1) Run discrete input
 - 2) No Fault discrete input
 - 3) Load discrete input
 - 4) Enable discrete output
 - 5) Pressure analog input
12. Remote Communication with the Condensate Drain Valve(s):
 - a. The controller shall communicate using the following I/O via hardwired conductors.
 - 1) Open discrete output
 - 2) Open discrete input
 - 3) Closed discrete input
13. Remote Communication with the Valve Modules:
 - a. The controller shall communicate using the following I/O via hardwired conductors.
 - 1) Valve Open discrete output
 - 2) Pressure analog input
 - 3) Controller heartbeat discrete output
 - 4) In Remote discrete input
 - 5) Zombie In Control discrete input
14. Remote Communication with Plant Control System:
 - a. An RJ45 Ethernet port shall be provided for connection to the Plant Control Network.
 - b. The controller shall communicate via Ethernet/IP
 - 1) System Low Pressure
 - 2) Compressor(#) Running
 - 3) Compressor(#) Fault
 - 4) ZVM(#) Running
 - 5) ZVM(#)Fault
 - 6) ZVM(#) Not In Remote

2.04 REMOTE I/O PANEL (RIO)

- A. Wall Mount Enclosure. RIO shall have UL-rated NEMA 4 painted steel enclosure.
- B. Power Connection. RIO shall accept a single source 120 VAC power connection. Lightning and surge protection shall be provided on the incoming line power.
- C. RIO PLC Hardware. RIO shall be equipped with an Allen Bradley CompactLogix 5069-AENTR ethernet adaptor which communicates with the MCP via Ethernet IP protocol.
- D. Ethernet Switch RIO Panel shall include a Hirschmann Model RS20-0800M2M2SAE Ethernet switch.
- E. Control of the Primary Influent Channel Mixing shall be via a Remote I/O Panel (RIO) installed at the pipe gallery that is connected to the plant Ethernet network via fiber optic connection.
- F. One I/O panel shall be provided and installed in the pipe gallery as shown on the Drawings. The I/O panel shall have all the I/O required by Manufacturer to operate the Primary Influent Channel mixing system.

2.05 ZOMBIE™ VALVE MODULE (ZVM)

- A. ZVM Enclosures: The ZVM enclosure shall be 304 stainless steel and all components shall be rated for a maximum ambient temperature of 115°F. The ZVM shall be built in accordance with UL standards and rated Nema 4X for outdoor duty.
- B. Support Stand: ZVM shall be provided with an aluminum support stand unless wall mounted.
- C. Heater: ZVM located outdoors shall be provided with a 120 VAC heater designed to maintain 40° F in an ambient outside temperature of 20° F. The heater shall be equipped with a thermostat to turn the heater off at temperatures above 55° F.
- D. Power Connection: ZVM shall accept a single source 120 VAC power connection. Lightning and surge protection shall be provided on the incoming line power.
- E. ZVM Operator Interface: The ZVM shall have a Local-Off-Remote (LOR) selector switch, a Frequency dial, and a Duration dial. In Local control the 'Duration' dial and the 'Frequency' dial inside the ZVM shall allow the operator to adjust mixing intensity locally. In Remote control, the MCP controller shall control the mixing intensity. If there is not a master control panel the remote position will function the same as the off position
- F. Zombie™ Controller:
 - 1. ZVM shall be equipped with a Zombie™ controller. The controller shall be rated for a - 40°F to 176°F temperature range, Class I, Division 2 Hazardous Areas, and be submersible in up to 3 feet of water.
 - 2. The controller shall be programmed to operate according to the dial settings for valve open frequency and duration when the LOR is in Local mode.
 - 3. The Zombie™ controller shall automatically take control of the ACVs based on the local settings if the discrete heartbeat signal from the MCP controller is lost and shall automatically relinquish control when the MCP controller heartbeat is restored.
- G. Air Control Valves (ACVs): The air control valves shall be mounted to a common manifold. The valves are tested to minimum of 15,000,000 cycles.
- H. Nameplate: A stainless steel nameplate shall be provided on the ZVM. The nameplate shall be securely fastened in a conspicuous place and clearly inscribed with the Manufacturer's name, year of manufacture, and serial number.
- I. Alarm Light: A red stack light shall be mounted on the top of the ZVM and indicate an alarm condition specific to the ZVM.
- J. Control & Operation:
 - 1. Control shall allow mixing to be started and stopped, and mixing intensity to be adjusted at any point during operation. Control features shall be initially set according to Manufacturer recommendations.
 - 2. Mixing Parameters: The operator shall be able to enable/disable mixing operation, select the firing duration and the frequency of firing. Minimum control features selected through the local interface shall include the following:
 - a. Local-Off-Remote (LOR) Switch:
 - 1) Local Position. In Local, the Zombie™ controls the ZVM mixing intensity. The 'Duration' dial and the 'Frequency' dial inside the ZVM shall allow the

- operator to adjust mixing intensity locally.
- 2) Remote Position. In Remote, the MCP Controller shall control the ZVM mixing intensity based on mixing parameters from the MCP OIT. If the system does not have an MCP, this mode will function the same as the Off position.
- 3) Off Position. In Off, the ZVM will be disabled locally and remotely.
- b. Duration Dial: Length of time an individual ACV is open during a firing event. The duration shall be operator adjustable from 0.1 to 1 seconds by adjusting the dial. The duration will be the same for all ACV's in the ZVM.
- c. Frequency Dial: Length of time to complete the firing sequence. Frequency shall be operator adjustable from 1 to 100 seconds by adjusting the dial.
- d. Valve Isolation: Individual ACVs may be removed from the firing sequence at any point during operation by unplugging the solenoid from the ACV. Alternatively, the header supply pipe isolation valve can be closed.
- e. Alarms: Each ZVM shall come equipped with a pressure transducer plumbed to the valve manifold which is transmitted back to the MCP. The MCP controller interprets the pressure to provide a low system pressure alarm and monitor ACV position.

2.06 AIR COMPRESSORS

A. High Pressure Air Compressors

1. Three (3) air compressor modules shall be as noted in the Design Table below. Each shall include an inlet air filter, compressor with an AC motor, air/oil separator reservoir, air cooled oil cooler, cooling fan or water cooling system, separator pressure relief valve, discharge check valve, moisture separator, controls, control panel, base, and unloading system.
2. Units equipped with water cooling systems shall have supply control valves which is either solenoid or motor actuated furnished by system manufacturer. System manufacturer shall provide open/close and status feedback to the supply valve from their control system. A pressure regulator shall be installed on the supply line to the compressor unit and set at compressor manufacturer rated pressure.
3. Each compressor module shall be completely factory assembled requiring only field connection of electrical power, air piping, and condensate drain tubing.
4. Each compressor shall be of the single stage, positive displacement, oil-flooded, rotary screw type. The compressor shall be provided with an integral skid or lifting lugs for unloading and placement.
5. Each compressor rotors shall be asymmetrical, steel or high strength ductile iron integral shafts, and dynamically balanced. Housings shall be cast iron. Rotors and housings shall be precision machined for accurate bearing positioning and running clearances.
6. The drive arrangement shall be a direct driven design.
7. Positive pressure lubrication shall be provided by an inherent pressure differential system. Lubricant shall be provided as recommended by the Manufacturer. A lubricant filter shall have a high-capacity 10 micron rating.
8. An air/oil separator reservoir shall be provided for each compressor. The reservoir shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp. The reservoir shall include two-stage filtration to remove oil from air stream. Oil carry-over downstream of compressor modules shall not exceed 3 mg/m³.
9. Each air compressor shall have a regulating system which is of the variable-speed design, controlled by an air compressor discharge pressure sensor which senses the pressure variations at the compressor discharge and adjusts the speed of the compressor to

maintain a stable discharge pressure. The full variable-speed regulation shall be combined with start / stop regulation to automatically stop the compressor as required during low demand periods without idling.

10. Each baseplate shall be constructed of one-piece folded mild-steel with structural members and shall be designed for no measurable deflection with the equipment mounted thereon and the baseplate supported around its perimeter. Each base shall be designed so that all equipment bolted to it can be removed without access to the underside of the plate and with a flat top surface for ease of cleaning. Structural stiffeners shall be located under the compressors at the compressor anchor points.
11. Valves and piping within the enclosure shall be the compressor manufacturer's standard. Relief valves shall be provided for equipment protection on the air and coolant systems as required.
12. Each compressor shall be provided with an integral, dry-type intake filter. Intake filters shall have replaceable filter element(s). Particle arrestance shall be not less than 99.9% efficient at 10 microns and above.
13. Each compressor shall be supplied in a sound attenuated enclosure. The enclosure shall reduce the measured sound to a maximum of 85 decibels, as measured by ISO 8571, while the compressor is operating, and the sound level is measured a distance of three feet from the enclosure.
14. A high air/fluid temperature shutdown system shall be provided. The unit must have safety devices mounted and wired. Safety devices shall include motor thermal overload and high compressor discharge temperature shut-down. These systems must be designed to prevent the compressor from running in an over temperature situation or motor from running in an overload condition.
15. Each compressor shall feature controls capable of operating at two pressure settings, set up and selected in the controller. The controller shall allow one of two different pressure control settings to be chosen so that if the demand is greater than one unit's capacity (the lead compressor), a second compressor (the lag compressor), if installed, will automatically turn itself on until the excess demand has been satisfied. The lag compressor's motor will shut down after a set period in which it is not loaded as described in paragraph above. The lead/lag pressure settings shall be fully incorporated inside the compressor's control panel. No additional separate control sequence panels shall be required.
16. The compressors shall be as manufactured by Atlas Copco, Model GA110VSD+ and Model GA18, or equal.

B. Refrigerated Dryer

1. An air dryer shall be provided of cycling refrigerated air type. The dryer shall produce 37-39°F pressure dew point at the dryer exit when operating continuously at 100 psi and 100F inlet air ambient temperature.
2. The dryer shall be capable of continuously drying the maximum discharge capacity of the air compressor.
3. The dryer shall be integral or separately mounted to the compressor package.

C. Free Standing Air Receiver

1. Three (3) air receivers shall be provided. The receivers shall be designed and constructed in accordance with the ASME Code of Unfired Pressure Vessels and shall bear the code stamp.
2. Receivers shall be factory powder coated. One quart touch-up paint shall be provided.
3. Each receiver shall be provided with mounting feet valve and pressure gauge.

4. Condensate Drain Valve:
 - a. Each receiver shall be provided with a 24 VDC motor-operated ½" FNPT stainless steel ball valve with deutsche connector powered, controlled, and monitored out of an adjacent MCP. A deutsche x pigtail connector shall be provided
- D. Compressor System Particulate and Coalescing Oil Filters
 1. Replaceable-cartridge primary particulate and secondary high-efficiency oil-removal filters shall be provided for the compressor package. Following both filters, the maximum particulate size removal shall be to 1 micron and coolant removal shall be to 0.1 mg/m³ at 21°C.
 2. The filters shall be rated for the maximum discharge capacity of the air compressor.
- E. Compressor System Electrical
 1. All electrical and control equipment for the air compressor module shall be furnished as required for a complete installation, requiring only field connection of a 480 VAC, three phase power supply
 2. The compressor electric motor shall be rated 480 volts, 60 Hz, three phase.
 3. The drive motor shall be a totally enclosed, oil lubricated, permanent magnet motor with an enclosure rating of IP66 and inverter duty rated.
- F. Compressor System Control Panel - An enclosure-integrated control panel mounted on the compressor module shall include:
 1. Each compressor electrical control cabinet shall be a NEMA 1 rated enclosure.
 2. Variable speed drive as required by the manufacturer.
 3. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.
 4. Terminal blocks for all system wiring. Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers
 5. Controller shall be provided to indicate the following conditions; discharge pressure, compressor element discharge temperature, power on, hours of operation, operating mode.
 6. Remote mounted fusible disconnects with time delay fuses shall be provided by Contractor.
 7. The following I/O shall be provided at the compressor control panel and hardwired to the MCP.
 - a. RUN status discrete output
 - b. NO FAULT discrete output
 - c. ENABLE command discrete input
 - d. LOAD discrete output
- G. Compressor Shop Painting
 1. All components of the compressed air equipment system shall be shop primed and finish painted with the Manufacturer's standard paint system prior to shipment to the site.

H. Compressor System Performance and Design Requirements

1. The compressed air equipment shall be designed for the following operating conditions:

Ambient Conditions		
	Max Air temperature, F	115
	Min Air temperature, F	32
	Relative humidity, percent	80
	Site Elevation, FASL	750
Compressors No. 1 and 2 – Type 1		
	Number required	2
	Maximum discharge pressure, psig	104
	Capacity at operating target pressure, acfm	103 - 731
	Motor size, hp	150
	Max motor shaft speed, rpm	~3,600
	Furnish with cooling water system	
Compressor No. 3 – Type 2		
	Number required	1
	Maximum discharge pressure, psig	104
	Capacity at operating target pressure, acfm	120
	Motor size, hp	25
	Max motor shaft speed, rpm	~3,600

Receivers – Type 1		
	Number required	2
	Design pressure (psig)	200
	Nominal volume (gal)	1,060
Receivers – Type 2		
	Number required	1
	Design pressure (psig)	200
	Nominal volume (gal)	240
Filters		
	Type	Particulate and Oil Removal
	Number required	1 each/compressor
Refrigerated Air Dryer		
	Type	Cycling
	Number required	1 each/compressor (integral)
	Target Pressure Dew Point (°F)	35 - 39

I. Pressure Transducer

1. The compressors shall be equipped with a pressure transducer plumbed to the discharge piping or receiver to monitor the common discharge pressure from the compressors.
2. The transducer range shall be 0-150 psi (minimum) with ¼” NPT male threaded connection, stainless steel housing, and M12x1 flange connector. Transducer shall be NEMA 4, minimum ambient -10°F, and maximum ambient 150°F.
3. The transducer shall be 4-20 mA, loop-powered from the MCP. An M12 x pigtail adaptor shall also be provided for termination in a junction box adjacent to the device.

4. The transducer shall be as manufactured by Schneider or equal.

2.07 SPARE PARTS

- A. Provide spare parts that are identical to and interchangeable with similar parts installed.
 1. Five (5) Air Control Valves (ACVs) rebuild kit
 2. Five (5) solenoid
 3. Five (5) valve plug and cable assembly
 4. Five (5) relay
 5. One (1) compressor intake air filter element per compressor provided
 6. One (1) compressor oil filter element per compressor provided
 7. One (1) each compressor separator element per compressor provided
 8. Any other standard parts recommended by the Manufacturer.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with approved shop drawings, Manufacturer's printed instructions and as indicated.
- B. All nozzles on respective nozzle header shall be level within ½-inch of a common horizontal plane.

3.02 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified Manufacturer's technical representative shall be provided for installation inspection, testing, startup and training. The mixing system Manufacturer shall include the following site visits and days on site:

Service	Number of Trips	Number of Days/Trip
Installation Inspection and Testing	3	2
Compressor Installation Inspection and Testing	2	1
Startup and Training	2	3

3.03 FIELD PERFORMANCE TESTING AND GUARANTEE

- A. All mixer components shall be field tested with the respective basins full to the maximum water surface elevation.
- B. Exposed air piping shall be tested by Contractor for leaks using soapy water on all joints and applying 100 psi test pressure. Buried air piping shall be tested using this method before the trench is filled. Air piping in the tanks may be tested by submersing the piping in non-potable water and pressurizing the piping to 100 psi, in lieu of using soapy water on all joints. Pressure testing requirement shall not apply to supply piping downstream from VM or pre-manufactured nozzle headers.
- C. The Contractor shall operate each mixing system at the maximum water surface elevation in the basins for a continuous period of not less than 72 hours. The Contractor shall correct and

resolve all operating problems, deficiencies, etc., determined as a result of the tests.

- D. After the above testing is complete, field mixing performance testing of the installed compressed gas mixing system shall be performed by the Manufacturer as described below.
1. Mixing performance testing shall be conducted in the following basin(s):
 - One (1) Train of Aeration Basins (Pass 4)
 - Primary Influent Channel
 - Battery A Aeration Effluent
 - Battery B Aeration Effluent
 2. All personnel and equipment necessary to conduct and supervise all testing shall be provided by the compressed gas mixing system Manufacturer. Engineer/Owner shall be notified of the test to witness at their option and expense.
 3. The TSS shall be in typical operating ranges of 1,500 – 5,000 for Aeration Basin and Effluent Channels and 150 - 300 mg/L for the primary Influent Channel. No flow shall enter or exit the respective basin for two hours prior to and during the test.
 4. The compressed gas mixing system Manufacturer shall conduct total suspended solids (TSS) testing using a Cerlic TSS probe, or equal, suspended solids analyzer.
 5. Testing Procedure:
 - a. In the mixing test, the compressed gas mixing system shall have been in normal operating mode for at least two days prior to testing and must have TSS in the typical operating range indicated above.
 - b. For the Aeration Basin, four horizontal-plane sample sites for each zone to be tested shall be selected by the Engineer. At each sample site, three vertical samples shall be collected as follows: 24-inches from the surface, tank sidewall mid-point and 24-inches above the tank sidewall bottom. Each sample site must be a minimum of 4 ft away from any structure within the tank. The samples for each location shall be analyzed as described above.
 - c. For each Channel, six horizontal-plane sample sites for a 50-ft section of the channel shall be selected by the Engineer. At each sample site, two vertical samples shall be collected as follows: 18-inches from the surface and 18-inches above the tank sidewall bottom. The samples for each location shall be analyzed as described above.
 - d. The Coefficient of Variation (Cv) shall be determined for the sample set, excluding the maximum and minimum samples. The Cv shall be calculated by taking the resultant set of ten (10) samples as follows: $Cv = (100 \times \text{Standard Deviation of Ten Samples}) / (\text{Mean Value of Ten Samples})$.
 - e. If the Cv is less than or equal to 15%, then the mixer performance shall be acceptable for that location.
 - f. If the Cv is greater than 15%, then the mixer performance shall be unacceptable for that location and the Contractor and/or Manufacturer shall make all necessary improvements (at no additional cost to the Owner) and repeat the testing procedure at no additional cost to the Owner until the Cv is less than or equal to 15% for that location.

END OF SECTION

SECTION 13410 - BASIC INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for instrumentation installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 1.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each product specified.
 - 2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
 - 3. Digital Systems: Provide the following:
 - a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.
- B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
 - 1. Where Drawings are drafted by computer equipment, CONTRACTOR shall furnish files on a disk. These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.
 - 2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
 - 1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.
 - 2. Provide 1 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment.
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Codes and Standards:
 - 1. National Electric Code.
 - 2. Applicable State and local requirements.
 - 3. UL listing and labeling shall be adhered to.
- C. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.
- D. CONTRACTOR shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the Work is done. CONTRACTOR shall pay fees for permits, inspections, licenses, and certifications when such fees are required.
- E. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONTRACTOR shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of ENGINEER with or prior to submittal.
- F. CONTRACTOR shall be responsible for costs incurred to correct aforementioned errors brought to ENGINEER's attention. CONTRACTOR shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.
- B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR. Repair and replacement of damaged parts will be done at no expense to OWNER.
- C. CONTRACTOR shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPLIERS

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):
 - 1. West Michigan Instrumentation Systems Inc.
 - 2. Commerce Controls Inc.
 - 3. Feyen Zylstra

- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by ENGINEER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.
- C. Equipment Supplier: Equipment specified under Sections 13413 through 13899 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
 - 1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by ENGINEER.
 - 2. Direct purchase of any items in these Sections by CONTRACTOR is not in compliance with this Specification and will not be permitted.
 - a. Project Engineer/Project Manager's name shall be forwarded to CONTRACTOR and ENGINEER within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 EQUIPMENT

- A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.
- B. Enclosures shall be NEMA 1, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.
- C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.
- D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what circumstances and locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.
- E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.
 - 1. Pneumatic instruments shall have an input and output range of 3-15 psig. Units shall require a 20 psi supply. Provide an air set for each pneumatic unit or for each 20 psi manifold. Bubbler air sets, regulators, valves, etc., must be factory assembled on a subplate as specified and detailed.
 - 2. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.

- F. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field- and panel-mounted devices. Tags shall include ENGINEER's tag identification and manufacturer's tag identification if different from ENGINEER's.
 - 1. Tags shall be either stamped metal or laminated phenolic with white letters engraved on a black background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.
- G. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.
- H. Provide equipment identification nameplates complying with Section 16075. Nameplates shall contain ENGINEER's item designation and, for indicators and transmitters, design range and units of device shown.

2.03 SOURCE QUALITY CONTROL

- A. Processor panels, IO panels, and associated fiber control panels shall be tested at the factory prior to shipment to the Site. ENGINEER is to be given 5 weeks notice before the factory test date; ENGINEER will witness the tests. The purpose of factory testing is to verify correct functioning of equipment and conformity to Project requirements before shipment. The equipment supplier shall power up all of the panels, connect the panels with fiber optic cabling and Ethernet cabling and test all communication before Engineer begins factory test of the Engineer developed PLC and SCADA application software.
- B. Schedule factory test not before 8 weeks after Shop Drawing status of deliverable items under this Section is either N.E.T. or F.A.C.
- C. Engineer will download the PLC and application software for testing the engineer developed PLC and SCADA system programming.
- D. At completion of the factory test, the panels shall remain connected for 2 weeks to allow Engineer to correct any software errors.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.
- B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.

- D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.
- E. Drawings are not intended to show every detail of construction or location of piping, ductwork, or equipment. Where proper operation or construction makes it necessary or advisable to change location of piping, instrumentation equipment, air ducts, or other equipment, CONTRACTOR shall so inform ENGINEER for his approval and permission.

3.02 DEMONSTRATION

- A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

END OF SECTION

SECTION 13413 - OPTICAL FIBER CABLING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Product and installation requirements for the following:
 - 1. Fiber-optic (E-FO, C-FO, V-FO, FO) Cables.
 - 2. Fiber-optic Connectors, Couplers, and Patch Panels.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
 - 2. Product certificates, signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" Article below.

1.03 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Connected Equipment Manufacturer Certifications: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.
- C. UL Compliance: For cables that may be run in plenum ceilings or other air-handling spaces, provide cables tested for compliance with applicable requirements of UL Standard 910, "Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces." In addition, provide FO cables that have passed the UL VW-1 flame test.
- D. EIA/TIA Compliance: Comply with applicable requirements of EIA Standards, EIA-440, -455, -458, -475, -509, -568-b.3, and 598-a pertaining to optical fiber cable and system component construction and installation. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.
- E. Fiber Optics Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of fiber-optics cable systems. Installation must include installation of fiber-optics cable, fiber termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- F. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the

background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each fiber-optics cable segment shall be labeled at each end with its respective identifier.

- G. Fiber-Optics Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all fiber cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All fiber-optics interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- H. Patch Cords: Patch cords shall be provided for each fiber-optic port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed fiber-optic cable. Patch cord connectors shall be matched with patch panel connector type and network fiber module connector type as required.

1.04 COMMISSIONING

- A. Subsequent to hook-ups of FO system to signal sources and destination equipment, operate systems to demonstrate proper functioning. Replace malfunctioning FO cabling system items with new materials, and then retest until satisfactory performance is achieved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. FO Cables:
 - a. Corning Infinicor SX+ Optical Fiber, or Equal, for multi-mode applications.
 - b. Corning NexCor Optical Fiber, or Equal, for single-mode applications.
 - 2. FO Connectors and Couplers:
 - a. AMP Netcon.
 - b. AT&T Network Systems.
 - c. Corning.
 - d. Honeywell, Inc.
 - e. ITT Corp.
 - f. Thomas and Betts Corp.
 - 3. FO Patch Panels:
 - a. Panduit.
 - b. Volition.

2.02 OPTICAL FIBER CABLING SYSTEMS

- A. Fabricate system using manufacturer's standard materials as indicated by published product information and in sizes, types, and performance characteristics as indicated.
- B. FO Cables: Factory fabricated, single channel, all di-electric low loss glass type, fiber-optic multimode graded-index cables with the following operational and construction features:
 - 1. Multi-mode Fibers:

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- a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Core Diameter: 50 microns or as listed on Drawings.
 - d. Cladding Diameter: 125 microns or as listed on Drawings.
 - e. Subunit Size: 2.0 mm or as listed on Drawings.
 - f. Maximum Attenuation: Less than 2.5 dB/850 nm.
 - g. Minimum Bandwidth: Greater than 500 MHz-km.
 - h. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - i. Operating Temperature Range: -20 to +70 degrees C.
2. Single-mode Fibers:
- a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered all di-electric Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Cladding Diameter: 125 microns or as listed on Drawings.
 - d. Subunit Size: 2.0 mm or as listed on Drawings.
 - e. Maximum Attenuation: Less than 0.5 dB/1,350 nm.
 - f. Minimum Bandwidth: Greater than 500 MHz-km.
 - g. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - h. Operating Temperature range: -20 to +70 degrees C.
- C. FO Connectors: Stainless steel, fiber-optic cable connectors, capable of terminating FO glass cables with diameters from 8 through 1,000 microns. Fabricate connectors with optical fiber, self-centering, axial alignment mechanisms. Select ST or SC style connectors as required or shown on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions with the Installer present for compliance with requirements, and other conditions affecting the performance of optical fiber cabling system. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION

- A. Install fiber-optic cables and associated equipment and devices in accordance with industry standards and manufacturer's written instructions.
- B. Install fiber-optic cable without damage to fibers, cladding, or jacket. Ensure that media manufacturer's recommended pulling tensions are not exceeded. Do not, at any time, bend cables to smaller radii than minimums recommended by manufacturer.
- C. Install FO cables simultaneously where more than one cable is being installed in same raceway. Use pulling lubricant where necessary; compound used must not deteriorate cable materials. Do not use soap. Use a pulling means, including fish tape, rope, and basket-weave grips, that will not damage media or raceway.
- D. No splices are allowed, except at indicated splice points.

3.03 GROUNDING

- A. Provide grounding connections for FO cable and other system components as required by manufacturer's written instructions.

3.04 APPLICATIONS

- A. Install optical fiber cabling for project applications as detailed on drawings.

3.05 FIELD QUALITY CONTROL

- A. Testing: Testing shall be done by CONTRACTOR with at least 5 years of experience in testing fiber-optic cabling systems. CONTRACTOR shall test each fiber strand. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER. Any fiber-optic cable left non-terminated at the discretion of OWNER, shall be tested using an adequate light source to determine that all installed strands are not damaged.
- B. Fiber-Optics Cable: Each fiber strand shall undergo bi-directional testing for signal attenuation losses using power meter and light source. Testing shall also include Optical Time Domain Reflectometer (OTDR) at both 850 and 1,300 nanometers for all installed fiber strands.
 - 1. Recommended Test Equipment:
 - a. Multimode: Siecor OM-100F and OS-100D or equivalent power meter and light source.
 - b. Multimode: Siecor OTDRPlus with appropriate modules for testing.
 - 2. Tests:
 - a. Multi-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - b. Single-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - 3. Test Criteria: Signal loss of less than 10 dB through entire fiber path, including cable, couplers and jumpers.
- C. Documentation (Fiber Optic): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Fiber Test Results: The results of the fiber testing shall be entered into the form "Fiber Attenuation Tests Results." Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - 1. Each cable installed shall undergo complete testing in accordance with TIA/EIA TSB-67 to guarantee performance to this standard.
 - 2. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 - 3. Test Criteria: Pass rate to conform to latest TIA/EIA Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
- D. Acceptance: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and the receipt of documentation.

3.06 CLEANING

- A. Clean optical fiber cabling and components of dirt and construction debris upon completion of installation.

END OF SECTION

SECTION 13421 - FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Magnetic Flowmeter

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
 - 1. Magnetic Flow Meter:
 - a. Rosemount.

2.02 MAGNETIC FLOW METER

- A. Magnetic flow meters shall be either flanged or flangeless type as indicated. Meters 4 inches or smaller shall be wafer style. Meters 6-inch or larger shall be of flange design.
- B. Meter body shall be Schedule 10, 304 stainless steel or Schedule 40 steel with 150-pound ANSI flange or AWWA Class D flange when ANSI is not an available option. Meters 4 inches or smaller shall be wafer or flangeless style and shall be designed for installation between 150 Class and 300 Class ANSI, DIN, or BS pipe flanges.
 - 1. Wafer or flangeless style meters 4 inches or smaller shall have a ceramic, Teflon, or Tefzel liner and Hastelloy "C" or platinum electrodes as indicated.
 - 2. Meters 6 to 12 inches shall have Teflon or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
 - 3. Meters 14 inches and larger shall have an Elastomer or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
- C. Liner material shall be suitable for the process flow indicated on Drawings.
 - 1. Meters 4 inches or smaller shall be furnished with a Teflon or Tefzel liner. Exception: Ceramic liner shall be furnished for meters 4 inches or smaller used for lime slurry, sludge, and abrasive process flows.
 - 2. Teflon liner shall be furnished for meters 6 to 12 inches.
 - 3. Polyurethane liner shall be furnished for meters 14 inches and larger, or if not indicated otherwise on Drawings or in the Specifications.

- D. Electrodes shall be suitable for the process flow indicated on the drawings and shall be bullet nosed style made of Hastelloy "C." Exception: Platinum electrodes shall be provided for sodium hydroxide or other caustic process applications.
- E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.
- F. Meter shall be capable of withstanding continuous submergence in up to 30 feet of water without damage. Field coil design shall be such that they shall not overheat or otherwise be damaged if flow tube is not totally filled with fluid. Magmeters shall be provided with 2 grounding rings. Meter cables shall be factory sealed in meter head by manufacturer. Coordinate exact cable length between meter and transmitter with installation Contractor.
- G. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable locally via an integral push-button arrangement or via a remote intelligent terminal. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.
- H. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.
- I. Magmeter shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable. Ground ring tabs shall be of suitable length to extent above flanges of meter.
- J. Unit shall be supplied with an integral or local conduit-mounted flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display.
- K. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.
- L. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.
- M. Flow meter shall operate within Specifications on 120 volt AC plus 10 percent and 60 hertz plus 5 percent. Power consumption shall not exceed 25 VA for meters 24 inches and smaller, and 50 VA for meters 30 inches or greater.

- N. Input span shall be adjustable between 0-1 and 0-30 feet per second and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.
- O. System accuracy, including primary magnetic flow meter, shall be plus 0.5 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.
- P. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall have the ability to be either integrally or remotely mounted as specified. If not specified, converter shall be remotely mounted. It shall be housed in a NEMA 4X case. When remotely mounted, the signal cable shall be provided with the proper length.
- Q. Magmeter manufacturer shall comply with ISO9000 Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes. Provide spool-piece for meters sized 12 inches and smaller.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13423 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Cord type float switch.
 - 2. Radar Transmitter

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
 - 1. Cord Type Float Switch:
 - a. Anchor Scientific, Inc.
 - b. Consolidated Electric Co.
 - c. Pulsar, Inc.
 - 2. Radar Transmitter (exact model as shown on drawings):
 - a. Vega- Rated class 1, division 1 group c and d with remote indicator rated class 1, division 1 ground c and d.

2.02 FLOAT SWITCH (CORD TYPE)

- A. Direct acting float switch shall be furnished to automatically detect liquid level change. Liquid rise of 1 inch from rest position shall operate float switch and reset will occur when liquid level drops 1 inch. Mounting shall be to a 1-inch vertical pipe for multiple float applications or to a flange for a single float application as shown. Free cable hanging floats with weights shall not be acceptable.
- B. Float switch shall consist of 316 type stainless steel housing, mounting clamp for 1-inch-diameter pipe, flexible 3-conductor cable with a synthetic rubber jacket, and mercury switch. Inside float housing will be a (normally open/closed) mercury switch potted in epoxy. Electrical load for switch contacts shall be rated 115 volt AC at 0.5 horsepower inductive load.
- C. Three-conductor cable shall be 14 AWG with 105 strands per conductor made for heavy flexing service and underwater use. A green grounding wire shall connect internally to float housing.
- D. Provide mercury free float switches with molded ABS housing and Form C contact switch. CONTRACTOR shall ensure ampere rating is suitable for load shown on Drawing.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13424 - PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Pressure seals.
 - 2. Diaphragm seals.
 - 3. Pressure to current (P/I).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
 - 1. Pressure Seals:
 - a. Ashcroft.
 - b. OPW (Ronningen-Petter).
 - c. Red Valve.
 - 2. Diaphragm Seals:
 - a. Ashcroft.
 - b. ITT Conoflow.
 - 3. Pressure to Current:
 - a. Rosemount.

2.02 PRESSURE SEALS

- A. Pressure seals shall be of the isolation ring type.
- B. The seal construction shall consist of a body, 360-degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive sensing liquid and 2 assembly flanges. The Iso-Ring ID shall match the pipeline ID. The Iso-Ring OD shall not exceed the ID of the piping flange bolt circle. Units shall be designed to fit 125-pound, 150-pound, and 300-pound ANSI piping flanges, as shown on Drawings.
- C. When not shown, this information shall be obtained by CONTRACTOR from ENGINEER.
- D. The process liquid pressure is transmitted through the flexible cylinder wall and the captive sensing liquid to the pressure seal.

- E. The seal body shall be carbon steel unless otherwise required. Two assembly flanges are carbon steel or 316SS. Flexible elastomeric cylinder is Buna-N or natural rubber. Captive sensing liquid is 50 percent ethylene glycol and water mix or silicone (specify one).
- F. Seal weight in pounds not to exceed four times the nominal pipe size in inches.
- G. Installation: Centering gauges shall be provided to align the ID of the isolation ring with the ID of the process pipeline, holding the ring in place during installation.

2.03 DIAPHRAGM SEALS

- A. Diaphragm seals shall isolate the process measuring instruments from the process fluid. The diaphragm seal shall be of the removable type. The diaphragm seal shall be filled with liquid, compatible for the process shown to be measured on Drawings. The diaphragm seal shall be supplied with gaskets, bolts, capillary tubing, and fill fluids.

2.04 PRESSURE TO CURRENT (P/I)

- A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.
- B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.
- C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.
- E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent. Provide hand-held configurator.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13428 - ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Dissolved oxygen analyzer.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
 - 1. Dissolved Oxygen Analyzer:
 - a. Insite. See instrumentation drawings for specific requirements.

2.02 COMPONENTS

- A. Dissolved Oxygen Analyzer:
 - 1. Process dissolved oxygen (DO) analyzer shall consist of a field-mounted submersible sensor probe and an analyzer transmitter. Sensor probe shall be either self-cleaning type or type with a replaceable electrode-electrolyte-membrane cartridge. Cartridge type sensor shall expose no less than 4 square inches of membrane area to monitored liquid. Unit shall operate from 120 VAC, plus or minus 10 percent power.
 - 2. Analyzer/transmitter shall have direct-reading, multi-scale indicator on analyzer face or behind a window in the "space" enclosure. Enclosure shall be surface-mount or panel-mount in a general-purpose or NEMA 4 rating as shown. Provide cable between probe and analyzer/transmitter in length required. Provide "plug-and-receptacle" type connector. Female receptacle shall be suitable for mounting on junction box and shall have stainless steel shell. Connector shall have gold contacts, shall be hose-down rated, and shall be Brad Harrison Quick-change or equal.
 - 3. Analyzer output shall be an isolated 4-20 mA, DC signal proportional to D.O.
 - 4. Accuracy shall be plus or minus 0.3 ppm excluding effects of free Chlorine, Hydrogen Sulfide, and pH.
 - 5. Probe shall have automatic temperature compensation. Transmitter shall be capable of operating in an ambient of minus 30 to plus 50 degrees C. High and low adjustable control contacts shall be provided for remote use.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Basic Instrumentation Requirements.

3.02 FIELD QUALITY CONTROL

- A. Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.
 - 1. Satisfactorily calibrate each analyzer and instruct the plant personnel in the operation and maintenance of each analyzer.

END OF SECTION

SECTION 13430 - CONTROL PANELS AND CONSOLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Control panels and consoles.
 - 2. Switches, push-buttons, lights.
 - 3. Relays.
 - 4. Intrinsically safe isolator relays.
 - 5. Timing devices.
 - 6. Terminal blocks.
 - 7. Control power transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 - 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Switches, Push-Buttons, Lights:
 - a. Allen-Bradley (Type 800MR).
 - b. American Solenoid Company.
 - c. Arrow Hart (Type OB).
 - d. Electros witch. (Type M5, KW or Series 24)
 - e. Microswitch (Honeywell) (Series PW).
 - 2. Relays:
 - a. Potter-Brumfield (Type KUP).
 - b. Schrack North America, Inc. (Type CAD).
 - c. Schneider Electric (Square D). (Type KU).
 - d. Struthers-Dunn (Type A283).
 - 3. Latching Relays:
 - a. Deltrol (Type 105 ML).
 - b. Potter-Brumfield (Type KBP).

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- c. Struthers-Dunn (Type 255 or 455).
- 4. Signal Switching Relay:
 - a. Airpax.
 - b. American Zettler, Inc.
 - c. Aromat.
 - d. Potter-Brumfield (Type RIOL).
 - e. Sigma.
- 5. Intrinsically Safe Isolator Relay:
 - a. B/W Controls, Inc.
 - b. MTL, Inc.
 - c. R. Stahl, Inc.
 - d. Symcom, Inc.
 - e. Warrick Controls.
- 6. Solid-State Timers:
 - a. ATC (Series 306D).
 - b. Eagle Signal (Type DG100).
- 7. Solid State Repeat Cycle Timers:
 - a. ATC (Series 342).
 - b. Eagle Signal (Type DA100).
- 8. Terminal Blocks
 - a. Allen-Bradley (Type 1492-CE6).
 - b. Altech (Type CTS4U-N).
 - c. Schneider Electric (Square D) (Class 9080, Type KCA-1).
 - d. Thomas & Betts (100 series or 200 series).
 - e. Weidmueller (SAKD2.5N or SAK2.5).
- 9. Fusible Terminal Blocks:
 - a. Allen-Bradley (Type 1492-CE6).
 - b. Altech (Type CAFL4U).
 - c. Schneider Electric (Square D). (Class 9080, Type KH-1).
 - d. Weidmueller (SAKS1 or ASK1).
- 10. Control Power Transformers:
 - a. Acme.
 - b. Sola.
- 11. Textured Polyurethane Enamel:
 - a. Sherwin-Williams, Polane T and/or Polane HST.
- 12. Wire Markers:
 - a. Brady.
 - b. T&B.
 - c. Westline.

2.02 CONTROL PANELS AND CONSOLES

A. Sheet Metal Construction:

- 1. Panels and consoles shall be fabricated from sheet steel welded and bolted into a rigid self-supporting structure a maximum of 90 inches high and a minimum of 20 inches deep. Overall length shall be coordinated with space requirements as indicated by Drawings. Changes in length from that shown on Drawings must be brought to attention of ENGINEER within 90 days of Contract Award. Cost to modify floor plan or wall opening shall be at CONTRACTOR's expense after this 90-day period. Panel face layouts shown on Drawings are

intended to indicate relative position of all components. Supplier shall fix exact locations and overall dimensions to meet requirements of its equipment.

2. Panel and console bodies shall be 12 gauge minimum steel for panels up to 42 inches in width, and 10 gauge minimum steel for panels exceeding 42 inches in width. Panel subplates shall be same gauge as enclosure. Stiffening members shall be provided for strength and stiffness as required.
3. A minimum of 3 inches shall be provided between edge of panel subplate and outside walls of panel body to ensure adequate wire-way space for external wires entering panel. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Identification plates shall be laminated phenolic with white letters engraved on a black background and mounted with screws or double-back adhesive foam tape.
5. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.
6. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.
3. Panels shall have open bottoms except where structural members are required.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.
3. After fabrication, panel surfaces shall be given a phosphatizing treatment inside and out, and then finished with 2 coats of textured polyurethane enamel. Panel interior shall be painted white, ANSI No. 51. Exterior color will be selected by ENGINEER.
4. Panels shall have identical exterior finishes as selected by ENGINEER. Panel finishes on matching colored panels shall be identical. It is supplier's responsibility to achieve this result, especially for panels fabricated in different shops.

D. Pneumatics:

1. Interior panel piping shall be grouped, supported, and terminated at bottom of panel at bulkhead fittings unless indicated otherwise. Terminations shall be clearly tagged.
2. Tubing shall be color-coded per ISA RP7.2. Pneumatic systems shall be tested per ISA RP7.1.

E. Electrical:

1. Internal panel wiring shall be 19 strand No. 16 AWG, 90°C MTW, Class C stranded, or THHN/THWN approved as 90°C MTW. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.
2. Control wiring associated with control circuits de-energized when main disconnect is opened shall be color-coded red. Control wiring associated with control circuits which remains "hot" when main disconnect is opened shall be color-coded yellow. DC control wiring shall be color-coded blue. Ground wires shall be color-coded green. Terminal blocks shall be numbered in numerical order. Yellow wiring leaving panel shall be brought to an isolated set of terminal blocks.
3. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
4. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
5. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
6. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.
7. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with a voltage insulation in excess of maximum voltage carried therein.
8. Floor-standing panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
9. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
10. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are

intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.

F. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.
3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with red color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be push-to-test oil-tight construction with cap colors and voltages as required. Pilot light shall be supplied with Light Emitting Diode (LED) type light module.
- E. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 120 VAC or 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.
- B. Latching Relays: Latching relays shall be transparent enclosed plug-in type with mechanical or magnetic latching, mechanical holding device, contacts rated 120V at 3 amps, and continuous duty

coils. These relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

- C. Signal Switching Relays: Instrument relays shall be those relays switching a 1-5 VDC or 4-20 mA signal. Instrument relays shall be transparent enclosed plug-in type with indicating LED and mechanical holding mechanism. Relay contacts shall be dry circuit type rated 250 mA maximum. Contact material shall be a gold-platinum-silver alloy.

2.05 TIMING DEVICES

- A. Solid-state timers shall be plug-in type.
- B. Solid-state timers with ON or OFF delay cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.
- C. Solid-state repeat cycle timers with adjustable ON-OFF cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.

2.06 TERMINAL BLOCKS

- A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:

Black	120V power circuits de-energized when main disconnect is opened.
White	120V neutral conductors.
Red	120V control circuits de-energized when main disconnect is opened.
Yellow	120V control circuits which remain hot when main disconnect is opened.
Blue	Terminal blocks for DC wiring.
Gray	Terminal blocks for shields in DC wiring.
Green	Ground terminal blocks.
- B. For terminals associated with 120V nonisolated input cards, individually fused terminal blocks shall be used for 120V power to field devices.
- C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.07 CONTROL POWER TRANSFORMERS

- A. Control power transformers shall be sized to handle in-rush currents and to accommodate continuous load of circuits plus 25 percent future load with 5 percent or less voltage drop. Transformer primary voltage shall be as indicated on Drawings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 15050 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals.
 - 2. Record documents.
 - 3. Maintenance manuals.
 - 4. Quality assurance.
 - 5. Delivery storage and handling.
 - 6. Guarantee.
 - 7. Rough-ins.
 - 8. Mechanical installations.
 - 9. Cutting and patching.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, piping/ductwork transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate mechanical work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. A schedule indicating the system, line size, line material, joints, fittings, valves, insulation thickness, hanger type and spacing, test pressure and shop finish for each system shown on the Drawings and/or specified herein.
 - 2. Complete layout drawings of all pipe sleeves, ductwork, etc., showing all sizes and controlling elevations. These drawings shall be reproducible and submitted on tracing, mylar or sepia paper.
 - 3. No work shall be undertaken until such drawings, specifications and schedules have been approved by ENGINEER. Approval of this data by ENGINEER shall not relieve CONTRACTOR of responsibility for the completeness, coordination, and dependable operation of the system as installed.
- B. Product Data: Submit in accordance with requirements of Section 01330, product data covering the items included under this Division of the Work.
- C. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Permits, Inspections and Licenses: CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory or political subdivision thereof, wherein the Work is done, or any other duly constituted public authority.
 - 1. Upon completion of the Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit three copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses and certifications when such fees are required.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.05 PROJECT CONDITIONS

- A. Explosion-proof Requirements: All work and equipment located in areas designated "Explosion-proof" shall conform to all requirements of Article 500 of the National Electric Code for Class 1, Division 1, Group. D installations, except when otherwise noted. All mechanical equipment located in these areas shall be built from nonsparking material per AMCA Std. 401-66 Type B.
- B. Corrosive Area Requirements: All heating, ventilating and air conditioning equipment, controls, ductwork, piping, supports and hangers shall be made of materials resistant to the chemicals or gases to which they are exposed, or be coated with the appropriate resistant coatings.
 - 1. The following is a partial list of areas which require equipment, piping, ductwork, supports, anchors etc. to be corrosion treated:
 - a. grit and screen rooms,
 - b. enclosed primary sanitary treatment structures,
 - c. chemical storage and handling areas,
 - d. filter areas,
 - e. high-humidity areas,
 - f. wet wells, and
 - g. other areas as indicated on Drawings.
 - 2. Acceptable Manufacturers: Products shall meet the requirements of this Section and be the product of:
 - a. Liberty Plastics.
 - b. Plasite (Wisconsin Protective Coating Corp.).
 - 3. Hanger, supports, anchors in corrosive areas shall be 316 stainless steel or FRP unless otherwise noted on the drawings or herein.
- C. Painting and Identification: Painting of piping and drainage lines installed as a part of this Work will be done under Section 09900, Painting.
 - 1. CONTRACTOR under this Section shall identify and label lines clearly so painting contractor can apply correct color(s) to each pipe.
 - 2. CONTRACTOR under this Section shall apply pipe labels to the pipe after painting has been completed. The piping labels shall include the pipe material and flow direction.

- D. Motors: Motors shall comply with the specifications as set forth in Section 16220. Submit motor manufacturer's name with Shop Drawings for approval.
 - 1. All motors in Division 15 shall be TEFC Premium Efficiency unless noted otherwise in the specific Division 15 Sections or on mechanical drawing Schedules.
- E. Stainless Steel: All stainless steel referenced in the specifications is 304 Stainless Steel unless otherwise noted herein or on the drawings.

PART 2 – PRODUCTS

2.01 PIPE LABELS

- A. Provide Vinyl pipe label that attach to the pipe with tie-wraps or formed label that snaps on the pipe. Labels shall be rated for indoor and outdoor use.
 - 1. Label Manufactures: Seton Name Plate Corporation, W.H. Brady, James H. Matthews, or approved equal.
- B. Labels that use adhesive shall not be used.

Where product labels are not available for the media in the pipe, the contractor may paint the background the stencil the pipe product and flow arrow on the pipe.

PART 3 - EXECUTION

3.01 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.02 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements.
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Furnish, set, and grout or secure in place all required sleeves.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

- B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 1. Unless noted otherwise on Drawings, mount unit heaters 8'-0" above finished floor.
- C. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- D. Install systems, materials, and equipment to conform with approved submittal data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- E. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- F. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- G. Install access panel or doors where units are concealed behind finished surfaces.
- H. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.03 PIPE AND EQUIPMENT IDENTIFICATION:

- A. Label all piping showing contents and direction of flow.
- B. Place label adjacent to each valve and branch takeoff, at each side of a wall or partition through which pipe passes; and at 20 feet 0 inch spacing on straight runs.
- C. Label Manufacturers: Seton Name Plate Corporation, W.H. Brady, Topflight Tape Company, James H. Matthews, or approved equal.
- D. Paint or stencil 1-1/2 inch high black enamel block type letters or numerals on all equipment items

3.04 VALVE IDENTIFICATION:

- A. Brass Tags: 1-inch diameter, secured to each valve with brass S-hook and stamped with system designation and assigned number.
- B. Obtain existing valve schedule from Owner and review existing valve naming sequence. Submit proposed schedule showing proposed continuation of sequence to Architect / Engineer for approval. Provide a printed schedule, in duplicate, describing each valve by number, giving location and service for which used.

3.05 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the following requirements:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
- C. Upon written instructions from ENGINEER, uncover and restore Work to provide for ENGINEER observation of concealed Work.
- D. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- E. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- G. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.
- H. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

END OF SECTION

SECTION 15060 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of supports and anchors required by this Section is indicated on Drawings and/or specified in other Division 15 Sections.
- B. Types of supports and anchors include the following:
 - 1. Horizontal piping hangers and supports.
 - 2. Vertical piping clamps.
 - 3. Hanger rod attachments.
 - 4. Building attachments.
 - 5. Saddles and shields.
 - 6. Miscellaneous materials.
 - 7. Anchors.
 - 8. Equipment supports.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 Sections.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's assembly type Shop Drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
 - 2. Submit manufacturer's technical product data, including installation instructions, for each type of support and anchor.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each type of support and anchor.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

- C. Manufacturers Standardization Society of the Valves and Fittings Industry, Inc. (MSS) Standard Compliance:
 - 1. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - 2. Select and apply pipe hangers and supports complying with MSS SP-69.
 - 3. Fabricate and install pipe hangers and supports complying with MSS SP-89.
 - 4. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Hangers and Supports:
 - a. B-Line Systems, Inc.
 - b. Carpenter and Patterson, Inc.
 - c. Corner & Lada Co., Inc.
 - d. Elcen Metal Products Co.
 - e. Fee & Mason Mfg. Co., Div. Figgie International.
 - f. Anvil International.
 - 2. Saddles and Shields:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.02 MATERIALS

- A. Hangers, supports, and anchors shall be 304 stainless steel.
- B. Hangers, supports, and anchors shall be 316 stainless steel or FRP construction in corrosive environments unless otherwise noted herein or on the drawings.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.
 - 1. Adjustable Steel Clevis Hangers: MSS Type 1.
 - 2. Pipe Hangers: MSS Type 5.
 - 3. Adjustable Band Hangers: MSS Type 9.
 - 4. Pipe Rolls and Plates: MSS Type 45.

2.04 VERTICAL PIPING CLAMPS

- A. Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.
1. Two-Bolt Riser Clamps: MSS Type 8.

2.05 HANGER-ROD ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper piping systems.
1. Steel Turnbuckles: MSS Type 13.
 2. Malleable Iron Sockets: MSS Type 16.
 3. Steel Weldless Eye Nuts: MSS Type 17.

2.06 BUILDING ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.
1. Concrete Inserts: MSS Type 18. Inserts for concrete shall be 304 stainless steel for all applications in wastewater treatment and water treatment process areas unless otherwise noted on drawings.
 2. Top Beam Clamps: MSS Type 25.
 3. Steel Brackets:
 - a. Side Beam Brackets: MSS Type 34.

2.07 SADDLES AND SHIELDS

- A. Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Shields: MSS Type 40, of length recommended by manufacturer to prevent crushing of insulation.

2.08 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA Standard ML 1.
- B. Steel Plates, Shapes, and Bars: Provide products complying with ANSI/ASTM A 36.

- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1 part cement to 3 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- E. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors, and associated Work, Installer shall meet at Site with CONTRACTOR, Installer of each component of associated Work, inspection and testing agency representatives (if any), Installers of other work requiring coordination with Work of this Section, and ENGINEER for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper-plated or by other recognized industry methods.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.1 Pressure Piping Codes are not exceeded.
- F. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.1.
 - 2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8-inch and over, install wood insulation saddles.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.05 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.1 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for pre-set of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS

- A. Furnish to CONTRACTOR, scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.

- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.07 ADJUSTING AND CLEANING

- A. Adjust hangers so as to distribute loads equally on attachments.
- B. Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 15080 - MECHANICAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, tools, equipment, accessories, and services necessary for providing and installing mechanical insulation of all items as shown on Drawings and/or specified herein. All sizing required for preparation of painting shall be performed under this Section.

1.02 QUALITY ASSURANCE

- A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
 - 1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
 - 2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.
- B. CONTRACTOR shall furnish ENGINEER for approval a list of insulating materials and thickness for items listed on Schedule. The list shall be complete including all types and thicknesses of insulation used for the various services as well as the limits of Work.
- C. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to Site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three years.
- B. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Type I Insulation:
 - a. CSG.
 - b. Manville - Micro-lok 650.
 - c. Owens/Corning Fiberglass.
 - d. UpJohn Company.
 - 2. Type II Insulation:
 - a. Armacell AP Armaflex.
 - b. Manville – Aerotube.
 - c. Rubatex.
 - 3. Paint for Exposed Pipe Insulation:
 - a. Arabol.
 - b. Fosters.
 - c. Lagfas.

2.02 MATERIALS

- A. Insulation for each of the applications listed on Schedule shall be one of the following types:
 - 1. Type I Insulation shall be a precision molded pipe covering composed of bonded fiberglass wool resin, minimum density 7.25 pcf, or polyurethane or phenolic foam minimum density 1.8 pcf formed in two half cylinders.
 - a. Indoor insulation cover shall be the all service jacket ASJ type with integral vapor barrier unless otherwise noted on Schedule, and outdoor insulation cover shall be 0.016-inch aluminum jacket.
 - b. All ASJ jacket laps and butt joint strips shall be of the adhesive contact type. Aluminum jackets shall have mastic laps and butt joints and banded using soft aluminum bands on 12-inch centers.
 - c. Fittings and valve insulation shall be fabricated from mitered segments of pipe insulation or molded fitting covers. Fitting and valve insulation shall be coated with insulating cement, dried, coated with a vapor barrier mastic and, on indoor applications, wrapped with fiberglass reinforcing cloth and a second coat of mastic applied or, on outdoor applications, coated with a method recommended by the manufacturer and approved by ENGINEER.
 - 2. Type II Insulation shall be flexible tubing elastomeric thermal type with a minimum density of 5.5 pcf. Adhesives shall be as recommended by the insulating manufacturer.
 - a. Indoor and outdoor piping shall be finished by applying two coats of a protective insulation coating as recommended by insulation manufacturer.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer's Qualifications: Firm with at least three years successful installation experience on projects with mechanical insulations similar to that required for this Project.

3.02 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.03 INSTALLATION

- A. The Mechanical Insulation Schedule gives the application, type, temperature, and thickness of insulation required. This Schedule should be used with the following interpretations.
 - 1. Insulation thickness selection not shown on Schedule shall be based on the ASHRAE Standard for the conditions of 80 degrees F ambient air temperature with 80 percent relative humidity indoor, and -20 degrees F ambient air temperature with 90 percent relative humidity outdoor, with operating temperatures as listed on Schedule.
 - 2. Type I insulation thickness shown on Schedule is based on fiberglass with a k-factor (thermal conductivity Btu/hour/square foot/degree F inch) of 0.255 at 40 degrees F. Insulation thickness may be increased or decreased in direct proportion to the k-factor of the insulation material furnished.
 - 3. Ground-buried pipe shall be considered as all pipe with at least 5 feet of earth cover. Pipe with less than 5 feet of cover shall be considered as exposed exterior piping when determining insulation thickness.
 - 4. Roof Drains: Insulation of roof drains shall include the drain, or to the underside, or roof opening enclosures, risers, all laterals or horizontal runs and internal vertical drops above main floor slabs.
 - 5. Insulation within 7'-0" of walking surfaces (horizontal or vertical distance) shall be installed with protective jacketing.

3.04 PLUMBING PIPING SYSTEM INSULATION

- A. Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- B. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable and Non-Potable cold water piping.
 - b. Potable chilled water piping.
 - c. Plant effluent water piping.
 - d. Interior aboveground stormwater piping.
 - e. Plumbing vents within six lineal feet of roof outlet.
 - 2. Omit insulation of drain piping of the scrubber unit.

- C. Hot Piping:
 - 1. Application Requirements: Insulate the following hot plumbing piping systems:
 - a. Potable hot water piping.
 - b. Potable hot water recirculating piping.
 - c. Hot drain piping (where indicated).

3.05 AIR PIPING SYSTEM INSULATION

- A. Hot Low-Pressure Piping (to 250 degrees F (121 degrees C):
 - 1. Application Requirements: Insulate the following hot low-pressure piping
 - a. Low-pressure process air piping.

3.06 EQUIPMENT INSULATION

- A. Cold Equipment (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold equipment:
 - a. Pneumatic water tanks.
- B. Hot Equipment (Above Ambient Temperature):
 - 1. Application Requirements: Insulate the following hot equipment:
 - a. Condensate receivers.

3.07 INSTALLATION OF PIPING INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Exposed covering shall be cleaned and sized for painting.
- G. Premolded sectional covers shall be applied to flanges, fittings, and valves where possible. All other flanges, fittings, and valves shall be field-insulated and jacket applied manually. Insulation shall be the same thickness as that of the pipe.
- H. In general, pipe hangers will be sized to fit the pipe with insulation placed over the pipe hanger assembly (except hot water or steam piping where hangers are sized to fit the insulation with a

saddle). Insulation shall be grooved for hangers. The hanger area shall be completely filled with insulating material and sealed in vapor barrier areas.

- I. Insulation, where terminated at equipment connections, ends of pipe, etc., shall be tapered at a 45-degree angle and sealed.
- J. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
- K. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3-inch-wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3-inch-wide vapor barrier tape or band.

3.08 INSTALLATION OF EQUIPMENT INSULATION

- A. Install equipment thermal insulation products in accordance with manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using staggered joint method for both single- and double-layer construction where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges, and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least two inches. Apply over vapor barrier where applicable.
- H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, including metal vessel covers, fasteners, flanges, frames, and accessories.
- J. Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by manufacturer.

3.09 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Replacement insulation shall be of same thickness as existing insulation. Jacket of replacement insulation shall overlap and seal to the existing insulation.

3.10 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Insulation installer shall advise CONTRACTOR of required protection for insulation work during remainder of construction period to avoid damage and deterioration.

MECHANICAL INSULATION SCHEDULE

Application	Type	Temp.(°F)	Duct/Pipe Size Minimum Insulation Thickness						Remarks
			Interior			Exterior			
			< 2"	2"-4"	> 4"	< 2"	2"-4"	> 4"	
HVAC									
Steam and Condensate Piping	I	240	2	3	4	3	4	5	Install Aluminum Jacket on all duct in the incinerator room.
Cooling Air Ducts	III	50	-	-	1	-	-	1	
Cooling and/or Hot Air Ducts	III	50-120	-	-	1-1/2	-	-	1-1/2	
Outside Air Ducts	III	-20	-	-	2	-	-	-	
Return Air Ducts (cont.)	III	70	-	-	1	-	-	1-1/2	
PLUMBING									
Cold Water	I	40	1	1	1-1/2	1	1	1-1/2	All except ground-buried.
Hot Water/Tempered	I	180	1	1-1/2	2	-	-	-	
Hot Water Roof Drains	I	0	1-1/2	2	2	-	-	-	
PIPEWORK									
Low Pressure Air Supply and Discharge	I	-20	2	2	1-1/2	-	-	1-1/2	From Blower Discharge to connection below floor. Provide aluminum jacket on interior and exterior pipe
PROCESS PIPING									
Plant Effluent Water	I or II	40	3/4	3/4	NR	3/4	3/4	NR	All except ground-buried.

END OF SECTION

SECTION 15100 - PRESSURE PROCESS PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Provide all labor, materials, and equipment necessary for fabrication and production of the items specified in this Section and as shown on Drawings or listed on Schedule.
2. Unless otherwise noted on Drawings, or in this Section, pressure process piping 4 inches in diameter and larger shall be part of this Work.
3. Dismantling of existing piping and supports, where required or shown or noted on Drawings; piping connections to existing piping, structures, valves, gates, measuring devices, pumps and other equipment, including equipment erected under other Contracts, are included in Work of this Section. Piping shall contain necessary unions or companion flanges to allow ease of equipment removal.
4. Complete all the demolition work and repair thereof to existing walls and slabs as required for the installation of this Work including grouting of all sleeves and castings. Provide all necessary joint and coupling materials, including bolts, nuts and gaskets, wall castings or sleeves, and standard or special fittings. Furnish hangers, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and special fittings. Provide and secure in proper alignment, all sleeve and casting openings in existing walls and slabs, including repair thereof.
5. Provide all shop-applied interior and exterior pipe linings and coatings. Provide plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, painting, testing, and disinfection, as required to accomplish Work as specified and shown on Drawings.

B. Products Installed But Not Furnished Under This Section: Install process valves, hydraulic gates, flow meters, and other appurtenances which are furnished under other Sections and incorporated in the piping systems as shown on Drawings and specified in this Section.

1. All pipe insulation shall be accomplished under Section 15080. Under this Section of Work, all shop-applied surface coating shall be furnished as herein specified and pipe testing accomplished prior to insulating.
2. Sewers are specified under Division 2.
3. All exposed pipe, field-applied finish painting preparation and repair of existing painted surfaces shall be done under Division 9.
4. Floor and roof drain systems are specified under Section 15150.

C. Products Supplied But Not Installed Under This Section:

1. All piping, fittings, appurtenances, and shop-applied coatings shall be supplied as specified under this Section.
2. The installation and testing of Water Distribution and Pumping Mains shall be performed as specified in this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.
 2. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.
 3. Design details of joints and joint restraint shall be submitted to ENGINEER for ENGINEER's consideration and approval before ordering any pipe.
 4. Product Data: Submit product data covering the items included under this Section.
- B. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of Section 01770.

1.03 QUALITY ASSURANCE

- A. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.
- B. Codes, Ordinances, and Standards: Manufacture, storage, and erection of equipment under this Contract shall be in accordance with current ASA (ANSI), AWWA, and ASTM Standards. Standards and Specifications referenced herein shall be the current published edition. The manufacturer of the pipe and fittings shall furnish ENGINEER a certified statement that all pipe and fittings furnished by manufacturer meet the material requirements and have been inspected and tested in accordance with the applicable Specification and Standard.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Disinfection compounds shall be stored in well-ventilated areas protected from moisture and fire.
- B. Liquid Chlorine shall not be stored on Site except when more than one working day is required for disinfection. Prior approval from ENGINEER and the local authorities is required for gas chlorine storage.
- C. Storage:
1. All pipe and related items installed under this Section shall be stored as recommended by manufacturer.
 2. CONTRACTOR shall take all actions necessary to protect all items installed under this Contract including furnishing all special storage areas required by equipment manufacturers.
 3. Pipe shall be stored on suitable timber skids free from contact with the ground. Gaskets shall be stored in as cool, clean, and shaded a place as practical.
- D. Handling:
1. All items installed under this Contract shall at all times be handled as recommended by manufacturer and in such a manner as to avoid any damage.
 2. All special handling equipment and temporary supports shall be provided by CONTRACTOR.
 3. Items will be subject to inspection and approval upon delivery to the Site and after storage. No cracked, broken, or damaged pipe shall be used.
 4. In the event coatings are damaged, the damaged area shall be recoated with an approved coating similar to that specified for that item.

5. Steel pipe shall be handled by means of rubber or fabric slings. No hooks shall be permitted to come in contact with joint rings or be inserted in the ends of the pipe and fittings for any reason.
6. During handling, hauling, and storage of pipe, each piece shall be kept from contact with adjacent pieces by means of wooden blocks or timbers.

1.05 PROJECT CONDITIONS

- A. Existing Conditions: The Drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, CONTRACTOR shall so inform ENGINEER for ENGINEER's approval.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Adapter Flange Coupling (AFC):
 - a. EBAA Iron Sales, Inc. (Series 2100 Megaflange).
 - b. Smith-Blair, Inc.
 - c. Uni-Flange Corp.
 - d. Victaulic Co.
 2. Bolted Flexible Coupling (BFC):
 - a. Dresser Industries, Inc.
 - b. Smith-Blair, Inc.
 3. Grooved Couplings (GC):
 - a. Victaulic.
 - b. Grinnell.
 - c. Anvil.
 4. Plastic Pipe (PVC):
 - a. Spears.
 - b. Harvel.
 - c. JM Eagle.
 5. High-Density Polyethylene Pipe (HDPE):
 - a. Performance Pipe.
 - b. KWH.
 6. Equipment Connections:
 - a. Garlock.
 - b. Metra Flex.
 - c. Mercer Rubber Co.
 - d. Redflex.
 - e. Atlantic Metal Hose Co. (Vibra-flexor).
 - f. Allied Metal Hose Company.
 - g. Universal Oil Products Flexonics Division.
 7. Hangers and Supports:
 - a. Grinnell.
 - b. Elcen.
 8. Utility Markers:
 - a. ScotchMark mid-range markers, Model 1258, as manufactured by 3M Company.

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- b. 3M Marker Locator Model 1265.
- 9. Mechanical Joint-Retaining Glands, no substitution or "or equals" will be accepted:
 - a. "Megalug Series," as manufactured by EBAA Iron.
 - b. "Blockbuster 1400 Series," as manufactured by Uni-Flange (Ford Meter Box Co.).
- 10. Mechanical Sleeve Seals:
 - a. Thunderline Corp.
 - b. Calpico, Inc.

2.02 MATERIALS

- A. Disinfection Products:
 - 1. Liquid Chlorine shall not be allowed for this Project.
 - 2. Sodium Hypochlorite shall meet the requirements of AWWA B300. Containers shall have an expiration date marked at time of shipment to ensure that excessive deterioration has not occurred.
 - 3. Calcium Hypochlorite shall meet the requirements of AWWA B300.

2.03 PIPE JOINTS

- A. All joint material and lubricants shall be furnished with the pipe, including all joint material required for connection to equipment furnished under other Sections. All joint materials shall be assembled in accordance with standard practice and manufacturer's recommendations. All equipment connections shall be flanged, union, or grooved coupling so that equipment can be removed without disassembly of the connecting piping.
- B. Bolted Flexible Couplings (BFC): Bolted flexible couplings shall consist of a steel sleeve, with centering bead removed, rubber gaskets, follower rings, and a full complement of nuts and bolts. Couplings shall allow a deflection of approximately 4 degrees per joint.
 - 1. Couplings shall have a minimum middle ring thickness and minimum length as follows:

<u>Pipe Size (inches)</u>	<u>Middle Ring Thickness</u>	<u>Middle Ring Length</u>
4	0.203-inch	5-inch
6 to 12	1/4-inch	5-inch
14 to 20	5/16-inch	7-inch
24	3/8-inch	7-inch
30 to 48	3/8-inch	10-inch
54 to 72	1/2-inch	10-inch

- 2. Couplings shall have a maximum gap between pipe ends as follows:

<u>Sleeve Length</u>	<u>Max. Gap Allowed</u>
5-inch	1-inch
7-inch	2-inch
10-inch	3-inch

- 3. Couplings and accessories shall be galvanized and shall be shop coated with a sealer suitable for subsequent field painting or coating.
- 4. Restraint rods shall be installed across coupling

- C. Flanged Joints (FJ): Pipe flanges shall conform to American Standards: dimensions, ANSI B16.1 and threads, ANSI B2.1. Flange faces except stainless steel shall be coated with a rust inhibitor immediately after drilling.
1. Flanges for cast or ductile iron pipe and fittings shall be ductile iron and meet the requirements of AWWA C115 (ANSI 21.15).
 2. Flanges for steel plate pipe and fittings shall meet the requirements of AWWA C207 Standard Steel Ring Flanges, Class B, except high service discharge piping as noted on Drawings or on Schedule, shall be Class D.
 3. Flanges for stainless steel pipe shall be fabricated from stainless steel flat plate of the same composition as the pipe.
 4. Flanges for stainless steel tubing shall be constructed using standard steel angle face rings (Van Stone Connection) and galvanized carbon steel backup flanges.
 5. Flanged joints shall be made up with full-face 1/8-inch rubber gaskets. Gaskets for gas lines shall be neoprene and asbestos.
 6. Flanges shall be firmly bolted with machine, stud or tap bolts of the proper size and number meeting the requirements of ASTM A 307, Grade B. Joints made with bolts or bolt studs shall have a nut on each side. Bolt projection through nuts shall be equal, and where studs are used, bolt projection on each side of the flange shall be equal.
 7. All nuts and bolts shall be cadmium plated or hot-dip galvanized except on stainless steel flanges shall be 316L stainless steel.
 8. Flange connections to all flexible connectors and expansion joints shall have a lock washer under all nut and bolt heads, 2 control rods across each joint and steel retainer rings at each flange. All steel materials shall be galvanized.
 9. Flange joints shall not be used on ground-buried pipe.
- D. Grooved Couplings (GC): Provide rigid grooved couplings where shown or noted on Drawings or noted on Pipe Schedule. Flexible type shall only be used in applications approved by ENGINEER.
1. Grooved couplings and fittings may be used in lieu of flanged joints.
 2. Couplings shall conform to AWWA Standard C606.
 3. Gaskets shall be molded or extruded of an elastomer that is recommended by coupling manufacturer and that will satisfy the end use. End use includes consideration for pipe material and material being transmitted by the pipe.
 4. Generally, ductile iron pipe gaskets shall be halogenated Butyl compound, and steel pipe shall be an ethylene, propylene, diene-monomer (EPDM) compound.
 5. Shop Drawings submitted shall identify the gasket material, pipe material, and material being transmitted in the pipe.
 6. Cast iron or ductile iron fittings shall conform to the requirements of ANSI Specifications A21.10 or AWWA C110 with end preparation of a radius cut groove configuration.
 7. Standard weight steel pipe or better may be cut grooved in accordance with manufacturer's standard groove dimensions. Where pipe is less than standard weight, a ring shall be welded to steel pipe to form the necessary shoulder for the joint, or the pipe may be roll-grooved in accordance with manufacturer's recommendation for roll-grooving pipe as approved by ENGINEER.
 8. Ductile iron pipe in sizes 4-inch to 24-inch shall be radius cut grooved in accordance with manufacturer's specifications.

- E. Mechanical Joints (MJ): Mechanical joint shall conform to ANSI A21.10 and AWWA C110, or ANSI A21.11.
 - 1. Each joint shall be complete with rubber gasket, cast iron gland and a full complement of high-strength, low-alloy steel bolts and nuts.
 - 2. All mechanical joints are to be restrained in accordance with the paragraph on joint restraints.
- F. Screwed Joints (SJ): Screwed joints in steel plate, galvanized steel, or black steel pipe shall conform to American Standards: dimensions, ANSI B16.3; threads, ANSI B2.1. The ends of pipe shall be reamed and all burrs and cuttings shall be removed. Joints shall be sealed with Teflon thread tape or an approved compound.
- G. Welded Joint (WJ): Butt-welded joints shall be used whenever shown or noted on Drawings. Welding shall comply with the current AWWA Standard C206. Lap-welded joints may be used if approved by ENGINEER.
- H. Adapter Flange Coupling (AFC): Adapter flange couplings for steel or ductile iron pipe shall be provided where shown on Drawings.
 - 1. The coupling shall be designed to meet the test requirements of ANSI B16.1, 125-pound flanges.
 - 2. The coupling shall be designed to handle a 525 psi hydrostatic test and 175 psi working pressure at temperatures of -20 to 150 degrees Fahrenheit without leaking or requiring additional restraint.
 - 3. The coupling shall consist of a standard flange drilling (ANSI B16.1); a standard mechanical joint material (ANSI A21.11 or AWWA C111); and standard retainer gland construction (AISI 4140 steel setscrews, galvanized with ductile iron body ASTM A 536).

2.04 PIPING

- A. Black Steel Pipe (BSP): Black steel pipe shall meet the requirements of ASTM A 53, Schedule 80.
 - 1. Fittings: Fittings shall be wrought carbon steel manufactured in accordance with ANSI/ASTM A 234, and welded conforming to ANSI B16.9, B16.11, B16.28, MSS SP-79, ASTM A 234, WPA-Grade, equal in thickness to the pipe.
 - 2. Joints: Black steel pipe joints shall be welded with flange connections where required for connection to equipment in accordance with the paragraph on "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
 - 3. Coating and Lining: Ground-buried black steel pipe and fittings shall be coated on the outside with a cold-applied wax coating.
 - 4. All 6 inch to 12 inch exposed piping for Aeration supply piping shall be ASTM A53 Schedule 20 with Buttwelding Fittings.
 - 5. All 14 inch to 66 inch exposed piping for Aeration supply piping shall be ASTM A53 Schedule 10 with Buttwelding Fittings.
- B. Ductile Iron Pipe (DIP): Buried ductile iron pipe shall be either the Pressure Class indicated on Bid Form or on Schedule. If no classification is indicated, pipe shall be the highest Standard Pressure Class available. Ductile iron pipe shall be manufactured in accordance with AWWA C151 (ANSI A21.51). Pipe placed in buildings to be joined by flanges or grooved couplings for the pipe size shown shall have a minimum thickness of Special Thickness Class 53. Each pipe run shall be of the same class. Pipe sizes indicated are inside diameter (I.D.).
 - 1. Fittings for flanged ductile iron pipe shall be ductile iron or cast iron and shall meet the requirements of AWWA C110 (ANSI A21.10) and for 54-inch and larger sized shall meet the

requirements of AWWA C153 (ANSI A21.53). Fittings for mechanical joint ductile iron pipe shall meet the requirements AWWA C110 (ANSI A21.53) Ductile iron fittings shall be rated for 350 psi, pipe sizes 24-inch diameter and less and 250 psi for pipe sizes over 24-inch diameter, except that ductile iron flanged fittings shall be rated for 250 psi for all pipe diameters.

2. Cast iron fittings shall be rated for 250 psi, pipe sizes 12-inch diameter and less and 150 psi for pipe sizes over 12-inch diameter.
 3. Ductile iron joints shall be mechanical, bolted flexible coupling, and push-on, as specified under Pipe Joints, as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER. Joints shall meet the requirements of AWWA C111 (ANSI A21.11). All joint materials shall be furnished with the pipe.
 4. Coatings and Linings: Ductile iron pipe and fittings to be ground buried shall be coated by manufacturer on the outside with an asphaltic coating 1 mil thick, in accordance with AWWA C151 and C110 (ANSI A21.51) and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4. The pipe shall be supplied with and wrapped in polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) and shall be installed following Method "A."
 5. Exposed pipe and fittings shall be coated by manufacturer on the outside with a universal rust-inhibitive primer 2 mils minimum dry thickness, and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4.
- C. Galvanized Steel Pipe (GSP): Steel pipe shall meet the requirements of ASTM A 53 standard weight class.
1. Screwed fittings shall be 150-pound malleable iron galvanized for field installation and welded fittings ANSI B16.9, ASTM A 234, WPA Grade, equal in thickness to the pipe for factory fabrication.
 2. Galvanized steel pipe joints shall be flanged, shop welded, grooved coupling, bolted flexible coupling or screwed in accordance with the paragraphs under "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
 3. Coating and lining shall be galvanized after fabrication in accordance with ASTM A 153. No field galvanizing will be allowed.
- D. Plastic Pipe (PVC): Plastic pipe shall be designed, fabricated, and installed in accordance with these Specifications and as shown or noted on Drawings and listed on Schedule.
1. Plastic pipe shall meet the requirements of ASTM D 1785 (PVC) Schedule 80, socket end ASTM D 2467.
 2. Pipe sizes indicated are I.D.
 3. Plastic pipe fittings shall meet the same requirements as the pipe and connections shall be socket type ASTM D 2467.
 4. All plastic pipe joints shall be socket type in accordance with the paragraph on "Socket Type Joints."
 5. Installation shall be in accordance with the paragraph on "Pipe Installation." In addition, the recommendations of ASTM Committee D 20 on Plastics relating to the installation of flexible thermoplastic sewer pipe shall be followed. Hanger spacing shall be as shown or noted on Drawings and meet manufacturer's recommendations as approved by ENGINEER.
- E. Stainless Steel Pipe (SSP): Stainless steel pipe shall be designed and fabricated in accordance with the ASTM Standards A 312 and A 409, and as shown on Drawings.
1. The pipe and fittings and all appurtenant supports specified shall be made from 304 L stainless steel with a minimum No. 1 mil finish and a maximum carbon content of 0.035 percent.

2. Pipe schedule shall be as shown on Drawings or on Pipe Schedule.
3. Fittings shall be made to ASTM A 403 standards, to MSS SP-43 dimensional tolerances, and shall be equal in wall thickness to, and meet the conditions of, the pipe.
4. Special fittings shall meet the requirements of the pipe and shall be as shown on Drawings.
5. All welding shall be performed in shop and be accomplished using inert gas shielded-arc method. Where consumable electrode or filler wire is used, they shall be the same material as the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint.
6. All interior weld finishes shall equal the smoothness of a minimum No. 1 mil sheet finish. The weld bead shall be smooth evenly distributed with an interior projection not exceeding 1/16 inch beyond the I.D. of the pipe or fitting. All unevenness shall be finely ground to meet the above requirements. Coarse grinding shall not be permitted.
7. All exterior weld finishes shall be wire brushed with stainless steel brushes used only on stainless steel. The joints shall then be cleaned of all discoloration, and deposits left during welding shall be removed by pickling.

F. Stainless Steel Tubing (SST): Stainless steel tubing shall be designed and fabricated in accordance with ASTM Standard A 778 and as shown on Drawings.

1. The pipe and fittings and all appurtenant supports specified shall be made from 304 L stainless steel with a maximum carbon content of 0.03 percent.
2. Finish shall be No. 2 mil finish or better.
3. Tubing Thicknesses: Nominal pipe size indicated for pipe less than 14-inch shall be iron pipe size (IPS), and pipe 14-inch and larger shall be outside diameter (O.D.). Pipe shall be fabricated in the thickness as given in the following Schedule:

<u>Tube O.D.</u>	<u>Wall Thickness</u>
8-inch and less	14 gauge
10-inch to 18-inch	12 gauge
20-inch and greater	10 gauge

4. Fittings shall be made to ASTM Standard A 774, MSS SP-43 dimensional tolerances and shall be equal in wall thickness to, and meet the conditions of, the pipe.
5. Special fittings shall meet the requirements of the pipe and shall be as shown on Drawings.
6. All welding shall be performed in shop and accomplished using inert gas shielded-arc method. Filler material shall be extra low carbon and appropriate for use with the base metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint.
7. All interior weld finishes shall equal the smoothness of a minimum No. 2 mil sheet finish. The weld bead shall be smooth and evenly distributed with an interior projection not exceeding 1/16-inch beyond the I.D. of the pipe or fitting.
8. All exterior weld finishes shall be wire brushed with stainless steel brushes.
9. Finished pipe and fittings shall be immersion pickled in 6 to 10 percent nitric acid and 3 to 5 percent hydrofluoric acid prior to shipment.
10. SST joints shall be flanged, shop welded, bolted flexible coupling or screwed, in accordance with the paragraphs under "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER. Field welded joints shall not be allowed.

G. Polyvinyl Chloride Pressure Pipe (PVCP):

1. PVCP pipe shall be manufactured of PVC resin compounds Class 12454 A or B conforming to ASTM D 1784 in accordance with ASTM D 2241. Unless otherwise indicated on Schedule or Bid Form, all PVCP pipe shall have a pressure rating of 200 psi (SDR 21).
2. If used for potable water service, PVCP shall meet the requirements of AWWA C900 & 905, ANSI/NSF 14 and ANSI/NSF 61.
3. Fittings shall be cast or ductile iron of comparable class, provided with special gaskets for SDR size pipe.
4. Joints shall be bell and spigot type with a flexible elastomeric gasket conforming to ASTM D 3139. Joints shall be made using lubricant as supplied and as directed by manufacturer. If it is necessary to field cut a standard length of pipe, the new spigot end shall be prepared as recommended by pipe manufacturer.
5. After delivery, PVCP pipe shall be stored on a flat surface so that the barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet. If the pipe is to be stored for an extended period of time, it shall be covered with an opaque material so it is protected from the sun's rays and the bells shall be inverted in alternate rows so they are not supporting the direct load of the pipe. Deflection of any particular amount of PVCP pipe shall not exceed 5 percent.

2.05 WALL AND SLAB SLEEVES AND CASTING

- A. At all points where pipes must pass through the walls, floors, or slabs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings. Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be sealed at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of other walls, and at the top surface of floors and slabs with a rubber link seal.
- B. In general, the wall sleeve or castings shall be of the same material as the pipe. Iron pipe wall castings, wall pipe, transition sleeves, and solid sleeves shall meet the requirements of AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B.
- C. Steel sleeves and wall pipe shall not be painted in areas to be embedded in the concrete. Under this Section, all loose rust, scale, grease, or oil shall be removed prior to pouring of the concrete.
- D. Where watertightness is essential and at other locations where indicated on Drawings, wall castings, and sleeves shall be provided with an intermediate flange located approximately at the center of the wall.
- E. Sleeves and castings at the point of manufacture shall be coated on the inside with a universal rust-inhibitive primer 1.5 to 2.0 mils minimum dry thickness.
- F. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

2.06 EQUIPMENT CONNECTIONS

- A. The connecting piping to pumps and other equipment shall be supported independently of the pump or equipment so as to avoid any strain on the pump or equipment.
- B. All equipment connections shall be flanged or have unions to facilitate removal of the equipment.
- C. Piping to vibrating equipment shall contain control-rodged, retainer ringed flanges, flexible spool-type expansion joint of duct and chlorobutyl or Buna-N material as shown or noted on Drawings.
- D. All carbon steel shall be galvanized.

2.07 JOINT RESTRAINT

- A. Where water or air pressure exerts a disjoining force, at all pipe deflections over 20 degrees, and all tees and dead ends, joints shall be restrained, tied, or harnessed in a manner approved by ENGINEER.
- B. The restraint shall be applied to joints in each direction from the deflection an adequate distance to resist the axial thrust of the test pressure as shown on Pipe Restraint Schedule on Drawings. Fire hydrants shall be restrained from the main line to the hydrant. Details of all proposed joint restraint, showing the type and locations, shall be submitted to ENGINEER for approval. Concrete thrust blocks will not be permitted except where noted. All pipe and fitting restrained joints shall be rated for a minimum of 250 psi.
- C. For unit price items, joint restraint shall be considered as included in the prices Bid for the type and size of pipe listed on Bid Form.
- D. Acceptable methods of joint restraint are as follows:
 - 1. Ductile Iron Pipe: Mechanical joint pipe with EBAA Iron "Megalug Series," or Uni-Flange Block Buster 1400 retainers, shall be used when shown on Drawings. Megalugs or Uni-Flange Block Buster 1400 retainers may also be used to restrain joints for unanticipated deflection points, or where connections require a mechanical joint. Restrained joint glands and hardware shall have surfaces factory prepared and protected with a corrosion resistant coating system. Glands shall have a polyester or epoxy fusion bonded coating. Wedges, nuts and bolts shall have two coats of a heat cured blue fluoropolymer coating or alternatively made of stainless steel. No other manufacturers or types of mechanical joint-retaining glands will be accepted. Push-on joint pipe shall be restrained with American Lok-Ring, Flex-ring or Fast-Grip Gaskets, U.S. Pipe TR Flex, or equal.
 - 2. Steel Pipe: Studs and lugs AWWA Manual MII (studs galvanized).

2.08 JOINT HARNESSING

- A. Pipe and fittings that require harnessing shall be provided with standard lugs ASTM A 283, Grade B, or A 285, Grade C, or equal, meeting the requirements of AWWA Specification C111 or AWWA Manual M11, unless otherwise noted.
- B. Harness tie rods and nuts shall be mild steel meeting the requirements of ASTM A 193, Grade B7, or A 307, Grade B, or equal with American Standard threads. The nuts shall seat on steel plate washers. The rod, washers, and nuts shall be hot-dip galvanized ASTM A 153.

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Aeration System Improvements

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2.09 HANGERS AND SUPPORTS

- A. Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for piping, apparatus, and equipment installed under this Section. All supports and parts shall conform to the latest requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Specification or as detailed on Drawings. Materials shall be stainless steel.
- B. Hangers and supports shall be adequate to maintain the pipelines, apparatus, and equipment in proper position and alignment under all operating conditions with due allowance for expansion and contraction, and shall have springs where necessary. Hangers and supports shall be of standard design where possible and be best suited for the service required, as approved by ENGINEER. Supporting devices shall be designed in accordance with the best practice and shall not be unnecessarily heavy. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 5 for each hanger. Hangers shall have a minimum spacing in accordance with ANSI B31.1. Point loading hangers are not acceptable. Hangers shall be sling or saddle type.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamp, and structural attachments shall be beam clamps. All rigid hangers shall provide a means of vertical adjustment after erection. Generally, hangers shall be sized for supporting the pipe, excluding insulation. Proper pipe protection saddles shall be installed on pipes that are covered with insulation where hangers and supports are outside the insulation. Overhead hangers shall be supported by threaded rods properly fastened in place by suitable screws, clamps, inserts or bolts, or by welding. Saddle stands shall be of the adjustable type. Each stand shall consist of a length of steel pipe fitted at the base with a standard threaded flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to the floor, foundation, or concrete base.
- D. Anchors shall be furnished and installed where specified, shown, or required for holding the pipelines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to approval by ENGINEER. Materials shall be stainless steel. Inserts for concrete shall be stainless steel and shall be installed in the concrete structures where required for fastening supporting devices. They shall be designed to permit the rods to be adjusted horizontally in one place and to lock the rod nut or head automatically. Inserts shall be recessed near the upper flange to receive reinforcing rods. Inserts shall be so designed that they may be held in position during concrete pouring operations. Inserts shall be designed to carry safely the maximum load that can be imposed by the rod that they engage.
- E. Concrete supports shall be placed wherever shown or required under Division 3. Equipment shall be supported in accordance with manufacturer's recommendations.

2.10 CLEANOUTS

- A. Cleanouts shall be provided where shown or specified. Cleanout openings for pipe 8 inches or larger in diameter shall be not less than 6 inches in diameter (unless otherwise noted on Drawings).
- B. Cleanout openings for pipe 6 inches and smaller shall be of the same diameter as the pipe.

- C. Cleanout covers shall be standard 125-pound blind flanges, where conformation is required with the inside curvature of the pipeline, in which case the covers shall be flanged of proper shape with standard flange drilling.
- D. Covers shall be fastened by means of galvanized steel studs and nuts and shall be drilled and tapped for a 1-1/2-inch pipe connection. A 1-1/2-inch galvanized steel plug shall be furnished. The flange or conformed plugs shall be provided with a dowel or other suitable means to ensure proper setting.

2.11 TAPS AND PLUGS

- A. Where indicated or required, pipe or fittings shall be tapped to receive small or special fittings under this or other headings of the Work. Required taps shall be provided as part of this Work.
- B. All taps shall be temporarily plugged at point of fabrication.

2.12 SOURCE QUALITY CONTROL

- A. Tests, Inspections:
 - 1. All pipe and fittings delivered to the Project shall be accompanied by certification papers showing that the pipe and fittings have been tested in accordance with the applicable Specifications and that pipe and fittings meet the Specifications for this Project. All pipe and fittings will be inspected upon delivery to the Site by ENGINEER or OWNER's Representative. No cracked, broken, or damaged pipe or fittings will be allowed in this Work.
 - 2. Ductile Iron Pipe:
 - a. Each pipe shall be hydrostatically tested to 500 psi at the point of manufacture.
 - b. The class of nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, county where cast, year in which the pipe was produced, and the letters "DI" or "ductile" shall be cast or stamped on the pipe.
 - c. Where required, other designation marks shall be painted on the pipe or fittings to indicate correct location in the pipeline in conformity to a detailed layout plan.

PART 3 - EXECUTION

3.01 ERECTION

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

3.02 INSTALLATION

- A. Laying and Erecting Pipe: Pipe shall be installed as recommended by manufacturers or by the applicable AWWA installation manual or specification.
 - 1. Pipe shall be carefully laid to line and grade as shown on Drawings. Care shall be taken to keep the interior of the pipe clean and free from dirt and other foreign materials.
 - 2. Bulkheads or other means shall be used at the open ends of the pipe for this purpose. At the end of each day's work, ground-buried pipe shall have its working end bulkheaded.

3. Ground-buried ductile iron pipe shall be wrapped with polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) following Method "A."
- B. Field Cutting Piping: The spigot ends of all pipe lengths, which have been cut in the field, shall be ground to a smooth surface and painted with 2 coats of asphaltum metal protective paint.
- C. Bolted Flexible Couplings (BFC): All bolted flexible couplings shall be harnessed with tie bolts or studs across the joint, design based on test pressures.
 1. On cast iron or ductile iron pipe, tie bolts shall be installed between flanges across the coupling unless otherwise noted on Drawings or approved by ENGINEER.
 2. Piping of other materials shall be furnished with lugs. The number and size of the bolts and studs and other details of the harnessed joint shall be submitted to ENGINEER for review.
 3. Tie bolts or studs shall be galvanized.
- D. Concrete Cradle: Pipework shall be placed on Class "C" concrete cradle in locations and according to details shown on Drawings.
- E. Bedding: Where the subgrade is disturbed during excavation, the space shall be refilled with bedding material solidly tamped to form a firm foundation for the pipe.
 1. At least the bottom quarter of the pipe shall be laid on a sand or pea gravel bedding, except that the bedding shall be exclusively pea gravel for pipe 48 inches and larger in diameter. Bedding shall be provided as specified under Division 2.
- F. Joints: All joints shall be assembled in accordance with that described in the "Pipe Joints" Article.
- G. Connections to Existing Facilities:
 1. CONTRACTOR shall furnish all labor and materials required for the connection of piping under this Contract to existing structures as called for on Drawings.
 2. Where breaking holes for connections to existing structures, care shall be taken to prevent debris from entering.
 3. After installation of the pipe, the structure shall be pointed up around the pipe, both on the inside and outside so that it is restored to a watertight condition.
- H. Connections to Existing Mains: Where shown on Drawings, connections of existing main to the new mains shall be done only after the new mains are shown to be disinfected by the results of the bacteriological analysis. Care should be taken to prevent debris from entering water main.

3.03 PIPE LOCATING SYSTEMS

- A. Utility Markers: All plastic pipe pumping mains shall have an electronic marker system furnished and installed complete with marker locator.
 1. Markers shall be installed in a horizontal position 3 to 4 feet below the ground surface.
 2. A marker shall be placed over every buried tee, bend, or saddle fitting, at intervals no greater than 100 feet along pumping mains and where directed by ENGINEER.
 3. Holes shall be excavated over bored or directionally drilled pumping main for placement of markers.

3.04 REPAIR

- A. Repair of all damaged interior pipe coatings, ground-buried exterior pipe coatings and galvanized coatings shall be under this Section. Repair of exposed painted pipe shall be as specified under Section 09900.
- B. For field-welded joints, both inside and outside, coatings shall be left off for a distance of 6 inches from each end. These areas shall be shop primed. After completing the welded joint and under this Section, the interior of all joints and exterior of ground-buried pipe shall be thoroughly cleaned, primed, and given field coating of the same material as specified for the pipe. Coating shall meet the requirements of AWWA C203 or AWWA C210, as approved by ENGINEER. Exposed field-welded joints shall be cleaned under this Section to remove slag and scale, and then shall be finish cleaned, primed and painted under Division 9.
- C. Damaged linings, coatings, and wrapping shall be repaired under this Section and, if possible, before pipe is laid.
 - 1. Surfaces shall be thoroughly cleaned, dried, and free of old materials.
 - 2. They shall then be given a field coating of the same material as specified for the pipe.
 - 3. Coating shall meet the requirements of AWWA C203, AWWA C210, or AWWA C602 as approved by ENGINEER.
 - 4. All other pipe coatings and linings shall be as stated in "Piping" Article.

3.05 AERATION PIPING REPAIR

- A. The existing portions of the aeration piping in the WPC galleries and tanks have leaks. As part of this project those leaks shall be repairs.
 - 1. ENGINEER and OWNER shall determine leaks that shall be repaired.
 - 2. The repair cost shall be based on the Unit Price Adjustment Table in the Bid Form and the Agreement. The table provides a range for pipe diameter sizes.
- B. Repair Approach
 - 1. Leaks at Gaskets – aeration pipe leaks at gaskets shall be addressed by disassembling the pipe joint and replacing the existing gasket. The joint shall then be reassembled using new bolt hardware.
 - 2. Leaks at Wall Penetrations – aeration pipe leaks at wall penetrations shall be reviewed to determine if the leak is at the joint between pipes or in the pipe wall material at the wall penetration. If the leak is at the joint the pipe shall be disassembled and repaired as indicated in prior section. If the leak is in the pipe wall material the existing wall sleeve shall be removed and a new sleeve shall be set in the wall. A new portion of pipe shall be installed through the wall and link seal shall be installed between pipe and wall sleeve.
 - 3. Leaks in Pipe Wall material – If the aeration pipe leaks are determined to be in the pipe wall the leak shall be corrected by welding a new portion of steel over the existing pipe surface. The patch material shall match the existing pipe wall thickness and shall extend 6-inch in all direction beyond the deteriorated portion of the pipe. The pipe surface shall be cleaned to determine the extents of the repair. After patch is installed the portion of the pipe shall be repainted.

3.06 FIELD QUALITY CONTROL

- A. Defective Pipe: No pipe or special casting known to be defective shall be laid in Work.
1. Any piece found to be defective after it has been laid shall be removed by CONTRACTOR and replaced by a sound and perfect piece.
 2. If the major part of a defective pipe is sound, the good end may be cut off and used.
 3. The cutting of pipes for this and any other purpose shall be done by skilled workers, and in such manner as will not injure the pipe. Every such cut shall be square and smooth. Cut surfaces shall be recoated as specified for the pipe.
- B. Tests:
1. After completion, each run of pipe shall be tested by CONTRACTOR in the presence of ENGINEER. All appurtenances such as service connections, corporation stops, and curb stops shall be tested with the run of pipe.
 - a. Any leaks shall be made tight.
 - b. Under this Work, CONTRACTOR shall furnish all water or air, piping, bulkheads, pumps or compressors, gauge, and other equipment required for the test.
 - c. The section of pipe to be tested shall be cleaned and isolated by valves or plugs, and shall not exceed 2,000 feet for any individual test. Such valves or plugs shall be designed to hold against the test pressure. Sections of pipe shall have an opening through which air or water can be introduced. The supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the pressure. The pressure gauge shall have a minimum diameter of 3-1/2 inches and a range compatible with the test pressure. Pipelines that cannot be closed for a direct pressure test shall be tested by filling the tanks to which they are connected to the highest operating level or installing temporary test bulkheads. After completion of tests, all pipes shall be drained. Buried pipelines shall be pressure tested with all pipe joints exposed for visual inspection unless otherwise directed by ENGINEER.
 - d. If requested by ENGINEER, CONTRACTOR shall furnish proposed test procedures for approval including pipe identification, test pressure and a description of the method of testing.
 - e. In the event that the leakage exceeds the specified amount, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or special castings found to be cracked shall be removed and replaced with new pieces by CONTRACTOR. After this Work has been done, the test shall be repeated. Final acceptance of the lines will not be made until satisfactory tests have been passed.
 2. Test Pressures: In general, pipelines shall be tested at 1-1/2 times their working pressure or at the test pressure indicated on Piping Schedule. Adjustments for hydrotest water temperature and water column elevation differences at point of test must be made.
 3. Hydrostatic Testing (except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.
 - a. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.

- b. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148,000}$$

where L = allowable leakage per hour (gallons)
S = length of pipe in test (feet)
D = nominal diameter of pipe (inches)
P = average test pressure (psi, gauge)

- c. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
- d. The test pressure shall not vary by more than 5 psi throughout the entire test period.
4. Pneumatic Testing: The section of pipe to be tested shall be filled with air and pumped up to test pressure.
- a. Sufficient time shall be allowed for the air pressures to stabilize at the test pressure. After the stabilization period, the air control valve shall be closed and the test period started. The section of pipe shall be maintained under the test pressure for a continuous 4-hour period with no more than a 10 percent loss in pressure over the entire test period.
- b. Pneumatic testing of HDPE pipe shall not be allowed.
5. Each valve assembly shall be tested by CONTRACTOR; the test shall consist of opening and closing the valve.
6. Each hydrant assembly shall be tested by CONTRACTOR; the test shall consist of flushing the hydrant for a minimum of ten minutes. During the test period the 6-inch gate valve shall be closed and opened. CONTRACTOR shall furnish necessary hoses for the disposal of OWNER-furnished water.

END OF SECTION

SECTION 15105 - BASIC PLUMBING PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Piping materials and installation methods common to more than one Section of Division 15 and includes pipe, fitting and joining materials, piping specialties, and basic piping installation instructions.
- B. All fastening hardware shall be 304 stainless steel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 15050, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit product data on the following items:
 - a. Escutcheons.
 - b. Dielectric Unions and Fittings.
 - c. Mechanical Sleeve Seals.
- B. Quality Control Submittals: Submit welders' certificates specified in Quality Assurance below.

1.03 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
 - 1. Welding procedures and testing shall comply with ANSI Standard B31.1.0, Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.
- B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-applied plastic end-caps on each length of pipe and tube except for concrete, corrugated metal, hub-and-spigot, and clay pipe. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.
- D. Store pipe in a manner to prevent sagging and bending.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pipe Escutcheons:
 - a. Chicago Specialty Mfg. Co.
 - b. Grinnell.
 - c. Sanitary-Dash Mfg. Co.
 - 2. Dielectric Waterway Fittings:
 - a. Epcos Sales, Inc.
 - b. Victaulic Company of America.
 - 3. Dielectric Unions:
 - a. Eclipse, Inc.
 - b. Perfection Corp.
 - c. Watts Regulator Co.
 - 4. Mechanical Sleeve Seals:
 - a. Thunderline Corp.
 - 5. Malleable Iron Unions:
 - a. Crane, No. 1259.
 - b. ITT-Grinnell, Figure 470.
 - 6. High-Impact Thermoplastic Wall Sleeve:
 - a. Thunderline.
 - 7. Silicone Rubber Adhesive:
 - a. General Electric.
 - 8. High Density Polyethylene Pipe (64.2):
 - a. Driscopipe 8000.
 - b. Nipak.
 - c. Dupont.

2.02 PIPE MATERIALS

- A. Refer to the individual piping system specification Sections in Division 15 for specifications on piping materials required from those listed from the following.

Steel Pipe (61.1)

Normal Service: Pressure to 150 psig
Temperature to 366 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Carbon steel pipe, Schedule 40, ASTM A 53 seamless or electric welded.
	6-inch and larger	Carbon steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE of JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Welded.
FITTINGS	1/4-inch through 2-inch	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3.
	2-1/2-inch and larger	Carbon steel, standard weight, butt welding, ANSI Standard B16.9.
NIPPLES	1/4-inch through 2-inch	Carbon steel, extra strong, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Malleable iron, 250-pound class (500 WOG), railroad type with brass seats.
FLANGES	2-1/2-inch and larger	Carbon steel, 150-pound class, weld neck, standard raised face. ANSI standard B16.5. Exception: Face shall be flat when matching C.I. such as for mission check valves.
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Garlock Blue - Gard, Style 3200 (Style 3800 for natural gas), ring type. Exception: For flat-face flanges use face gaskets of same material as above.
THREAD SEALANT		Pipe dope. John Crane Insoluble Plastic Lead Seal No. 2, or approved equal. Exception: For temperatures in excess of 250 degrees F, use Teflon ribbon, 1/2-inch wide.

Steel Pipe (61.3)

Normal Service: Pressure to 150 psig
 Temperature to 366 degrees F

Note: For condensate in sizes 1-1/2-inch and smaller use Schedule 80 pipe and fittings.

	Size	Specifications
PIPE	1/4-inch through 4-inch	Carbon steel pipe, Schedule 40, ASTM A 120 seamless or electric welded.
	Above 4-inches	Carbon steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 1-1/2-inch 2-inch and larger	Screwed. Butt-welded.
FITTINGS	1/4-inch through 1-1/2-inch 2-inch and larger	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3. Carbon steel, standard weight, butt welding, ANSI Standard B16.9.
NIPPLES	1/4-inch through 1-1/2-inch	Carbon steel, extra strong, ASTM A 120 or A 53.
UNIONS	1/4-inch through 1-1/2-inch	Malleable iron, 250 psig saturated steam rating, railroad type, with brass seats.
FLANGES	All sizes	Carbon steel, 150-pound class, weld neck, standard raised face. ANSI standard B16.5. Exception: Face shall be flat when matching C.I.
GASKETS	All sizes	1/16-inch Garlock Blue - Gard, Style 3200, ring type. Exceptions: For flat-face flanges, use face gaskets of same material as above. Use Teflon for CO ₂ and N ₂ . Use Gylon or Flexitallic Style CG stainless steel with Teflon fill for high temperature compressed air.
THREAD SEALANT		Teflon ribbon, 1/2-inch wide.

Steel Pipe (61.10)
(Galvanized)

Normal Service: Pressure to 150 psig
 Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel pipe, Schedule 40, ASTM A 120 butt or electric welded.
	6-inch and larger	Galvanized steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 4-inch	Screwed.
	5-inch and larger	Flanged.
FITTINGS	1/4-inch through 4-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	5-inch and larger	Galvanized cast-iron, 125-pound class, flanged. ANSI Standard B16.1.
NIPPLES	1/4-inch through 4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, railroad type, with brass seats.
FLANGES	2-1/2-inch and larger	Companion flanges, black cast iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.11)
(Galvanized)

Maximum Pressure: 150 psig
Maximum Temperature: 200 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded. Mill galvanized.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Mill galvanized. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	2-1/2-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 2-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, railroad type, with brass seats.
COUPLINGS	2-1/2-inch and larger	Malleable iron mechanical coupling with Grade M chlorinated butyl rubber gasket. Gustin-Bacon Series 100, Victaulic Style 77.
FLANGES	2-1/2-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.12)
(Galvanized)

Normal Service: Pressure to 150 psig
 Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Notes: 1. Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs. 2. To be mill galvanized having smooth appearance.
TYPE OF	1/4-inch through 2 1/2-inch	Screwed.
JOINTS	3-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2 1/2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	3-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 3/4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 3/4-inch	Galvanized malleable iron, 250-pound class, railroad type, with brass seats.
COUPLINGS	1-inch and larger	Malleable iron mechanical coupling with flush-seal type chlorinated butyl rubber gasket. Gustin-Bacon Series 100 with Type II gasket, Victaulic Style 77 with Grade E gasket. Exception: Butyl rubber gasket is suitable for system supplied with oil-free air only. If air compressors are oil-lubricated type, use Buna-N flush-seal type gaskets.
FLANGES	1-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
FLANGE GASKETS		1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Ductile Iron Pipe (62.5)

Normal Service: Pressure to approx. 250 psig
 Temperature to 180 degrees F

	Size	Specifications
PIPE	3-inch and larger	Ductile Iron, ASTM 21.51 (AWWA C151) and ASTM A 536, Grade 60-45-10 Class 54 cement-lined interior, coal tar varnish coating - ground-buried universal rust-inhibitive primer exposed.
TYPE OF JOINTS	3-inch and larger	Push-on joint, compression with restrained mechanical joint fittings - ground-buried, flanged or grooved coupling - exposed.
FITTINGS	3-inch and larger	Ductile Iron, ASA 21.10, 250 psi rating.
GASKETS	3-inch and larger	1/16-inch rubber.
FLANGES (when required)	3-inch and larger	Ductile iron, ANSI 21.15 (AWWA C115) dimensions ANSI B16.1; threads ANSI B 2-1, bolts ASTM A 307, Grade B. All nuts and bolts to be cadmium-plated.

NOTE: Ground-buried pipe to be restrained for pressures up to 180 psi as noted in the pipe restraint schedule.

Copper Tubing (63.1)

Normal Service: Pressure to 150 psig
 Temperature to 250 degrees F

- NOTES: 1. Use solder fittings at all joints between terminal points.
2. Bends may be used for 1/4-inch and 3/8-inch tubing. Bends shall be made with a bending tool to the following minimum radii:
- 1/4-inch: 9/16-inch min. radius
 3/8-inch: 15/16-inch min. radius

	Size	Specifications
PIPE	All sizes	Copper tubing, type L, hard-drawn above ground. Type K (soft) for below grade.
TYPE OF JOINTS	1/4-, 3/8-, 1/2-inch	Soldered or compression type as required. (see Note 1).
	5/8-inch and larger	Soldered. (Exposed.) Flared. (Buried.)
SOLDERED FITTINGS	All sizes	Wrought copper or cast bronze, solder-joint fittings. ANSI Standard B16.22.
COMPRESSION FITTINGS (EXPOSED)	1/4-, 3/8-, 1/2-inch	Brass compression type fittings. Gyrolok, Swagelok, Parker CPI.
UNIONS	1/4-inch through 2-inch	Wrought copper or cast bronze, solder joint union.
FLANGES	All sizes	Copper, solder-joint flange. 150-pound ASME drilling. Raised or flat face to match equipment.
GASKETS		1/16-inch Teflon; ring type for raised-face, or full-face for flat face flange.
SOLDER		Tin/Antimony (or lead-free to meet code requirements).
THREAD SEALANT (where necessary)		Teflon tape.

PVC Pipe (64.1)

Normal Service: Maximum Pressure: 150 psig
Maximum Temperature: 150 degrees F

	Size	Specifications
PIPE	1/2-inch through 6-inch	PVC Type I, Schedule 80, ASTM D 1785.
TYPE OF JOINTS	1/2-inch through 6-inch	Solvent welded.
FITTINGS	1/2-inch through 6-inch	PVC, Schedule 80, socket type, ASTM D 2467.
FLANGES (where necessary)	1/2-inch through 6-inch	PVC, 150-pound, flat-face, Schedule 80, socket type.
GASKETS	1/2-inch through 6-inch	1/16-inch solid neoprene, full-face type.

NOTE: Provide 20-gauge (0.032-inch) aluminum jacket on all piping in return air plenums.

Sodium hypochlorite and sodium hydroxide piping joints shall be made with Oatey, Lo-Voc heavy-duty gray, Industrial Grade PVC cement. PVC cement shall be NSF listed and meet ASTM D 2564 and D 1412. Cement shall be resistant to caustics and hypochlorites up to 15 percent solution.

CPVC Pipe (64.8)

Normal Service: Maximum Pressure: 100 psig
Maximum Temperature: 180 degrees F

	Size	Specifications
PIPE	1/2-inch through 2-inch	rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade I, with a Cell Classification of 23447 as defined in ASTM D1784
TYPE OF JOINTS	1/2-inch through 2-inch	Solvent welded.
FITTINGS	1/2-inch through 2-inch	CPVC, Schedule 80, socket type, ASTM F 439.
FITTINGS - THREADED (where necessary) LISTING	1/2-inch through 2-inch	CPVC, , Schedule 80 ,THREADED, ASTM F 437 Only for transition to different piping system approved by NSF for use with potable water

Stainless Steel Pipe (66.1)

Normal Service: Pressure to approx. 150 psig
 Temperature to 300 degrees F

	Size	Specifications
PIPE	1/2-inch through 6-inch	Types 304, 304L, 316 or 316L stainless steel pipe, Schedule 5S. ASTM A 312 seamless or electric welded.
TYPE OF JOINTS	1/2-inch through 6-inch	Butt-welded, Press Fittings or threaded as required.
FITTINGS	1/2-inch through 6-inch	Press Fittings by Viega or approved equal per ASME A312 or ASTM A554. Types 304, 304L, 316 or 316L stainless steel, schedule 5S, butt-welding. ASTM Standard A 403 and ANSI Standard B16.9, or tangential fittings as manufactured by Horace T. Potts Co. (Speedline) or by Picor, Inc.
FLANGED CONNECTIONS	1/2-inch through 6-inch	Types 304, 304L, 316 or 316L stub ends, schedule 5S, butt-welding. Type A or B as covered by MSS or ANSI. All stub ends must be true schedule 5 -- not taper-bored. Speedline or Camco 150-pound. C.S. lightweight backup flanges are permitted for stub ends.
GASKETS	1/2-inch through 6-inch	Press Fitting O-rings shall be EDPM or FKM depending on application 1/16-inch solid Teflon, ring type. (Gylon is an acceptable alternate where cold flow of Teflon could be a problem.)

2.03 JOINING MATERIALS

- A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- C. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions: Malleable-iron, Class 150 for low-pressure service and Class 250 for high-pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Insulated and gasketed, galvanized, malleable iron unions as manufactured by Crane No. 1259, ITT - Grinnell Figure 470, or equal.
- D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
- E. Sleeves: Unless otherwise shown on Drawings, at all points where pipes must pass through walls, floors or roofs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings meeting the requirements of Section 01600.
 - 1. In general, the wall sleeve or casting shall be of the same material as the pipe, or standard weight steel pipe thimbles of at least one size larger than the pipe itself shall be installed. Iron pipe wall castings, wall pipe, transition sleeves and solid sleeves shall meet the requirements or AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B. All sleeves shall be shop-coated with universal primer 2 mils minimum thickness.
 - 2. A high-impact thermoplastic wall sleeve as manufactured by Thunderline, may be used for low and standard temperature service.
- F. Sleeve Seals: Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be caulked at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of the other walls, and at the top surface of floors and slabs. The space shall be caulked with lead and oakum as specified under Bell and Spigot Lead with an RTV-silicone rubber adhesive as

manufactured by General Electric, or sealed with a rubber link seal. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION

- A. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Piping shall be exposed, unless indicated otherwise.
- C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on Drawings.
- E. Install piping far enough from slabs, beams, joists, columns, walls, and other permanent elements of the building to permit access for painting. Provide space to permit insulation applications, with 3-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.

- J. Buired Plastic Pipe: Install a yellow insulated copper tracer wire or other approved conductor adjacent to underground nonmetallic piping. The tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and unsulation type shall be suitable for direct burial.

3.03 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.
- D. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2-inch and smaller connections, and elsewhere as indicated.
- E. Install flanges in piping 2-1/2-inch and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.
- F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).
- G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).
- H. HDPE to Metallic
 - 1. Provide an anodeless transition fitting between the underground HDPE gas piping and the above ground metallic piping.

3.04 JOINTS

- A. Steel Pipe Joints:
 - 1. Pipe 2-inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 - 2. Pipe Larger than 2-inch:
 - a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
 - b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
 - c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping, and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.
2. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4-inch and smaller.

C. Joints for other piping materials are specified within the respective piping system sections.

3.05 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system Specification Sections.

END OF SECTION

SECTION 15110 - PROCESS VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section and as shown on Drawings or on Valve Schedule on Drawings.
- B. Items furnished under this Section shall be erected under Division 15. Hanger rods, inserts and supports, flange bolts, and gaskets for valves shall be furnished and installed under Section 15100.

1.02 REFERENCES

- A. ANSI:
 - 1. B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250, and 800.
 - 2. B16.3, B2.1 Threaded Valve Joint Standards.
 - 3. B16-104 Reinforced Teflon Steel Standard.
- B. ANSI/AWWA:
 - 1. C110/A21.10 Ductile Iron and Gray Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
 - 2. C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 3. C500 Metal Seated Gate Valves for Water Supply Service.
 - 4. C507 Ball Valves.
 - 5. C504 Rubber Seated Butterfly Valves, 3-Inch through 72-Inch.
 - 6. C508 Swing-Check Valves for Waterworks Service, 2-Inch Through 24-Inch
 - 7. C509 Resilient Seated Gate Valves for Water Supply Service.
 - 8. C512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - 9. C515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
 - 10. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves
 - 11. C530 Pilot Operated Control Valves
 - 12. C541 Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
 - 13. C542 Electric Motor Actuators for Valves and Slide Gates
 - 14. C550 Protective Interior Coating for Valves and Hydrants
- C. ASTM:
 - 1. A 48 Specification for Gray Iron Castings.
 - 2. A 126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 3. A 182/A 183M Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
 - 4. A 183 Specification for Carbon Steel Track Bolts and Nuts.
 - 5. A 194/194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
 - 6. A 276 Specification for Stainless and Heat Resisting Steel Bars and Shapes.
 - 7. A 436 Specification for Austenitic Gray Iron Castings.

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| 8. | A 536 | Specification for Ductile Iron Castings. |
| 9. | B 148 | Specification for Aluminum Bronze Castings. |
| 10. | B 584 | Specification for Copper Alloy Sand Castings for General Applications. |
| 11. | B 61 | Specification for Steam of Bronze Castings. |

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Each valve, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Valve Schedule.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- C. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. All Work under this Section shall be performed in accordance with standard practices as recommended by manufacturer and AWWA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Butterfly Valves (B):
 - a. DeZurik.
 - b. Henry Pratt Co.
 - c. M&H Valve Co.
 - d. Rodney Hunt Co.
 - e. Val-matic Valve and Manufacturing Corp.
 - 2. Industrial Butterfly Valves (IB):
 - a. Cooper Cameron Corp. (Demco Valve).
 - b. DeZurik SPX.
 - c. Henry Pratt Co.
 - d. Hilliburton Co. (Dresser Valve Div.).
 - e. Kennedy Valve.
 - f. Keystone Valve.
 - g. Mark Controls Corp. (Center Line Valve).
 - 3. Resilient Seated Gate Valves (RA):
 - a. American Flow Control Valves.
 - b. Clow Valve Co.
 - c. M&H Valve Co.
 - d. Mueller Co. (A-2360 Resilient Wedge).
 - e. U.S. Pipe (Metroseal 250).

4. Standard Swing Check Valves (C):
 - a. Clow Valve Co.
 - b. G.A. Valves (Golden Anderson).
 - c. Kennedy Valve.
 - d. M&H Valve Co.
 - e. Rensselaer Valve Mfg. Co.
5. Double Vane Check Valves (DC):
 - a. Mission Manufacturing Co. - Duo-Chek.
 - b. Techno Corporation - Technocheck.
6. Plug Valves (P):
 - a. Clow Valve Co.
 - b. DeZurik.
 - c. Homestead Valve (Div. of Olson Technologies, Inc.).
 - d. Milliken Valve Co.
 - e. Henry Pratt Co.
 - f. Val-Matic Valve and Manufacturing Co.
 - g. Victaulic Co.
7. Tapping Sleeves and Valves (TPSV):
 - a. A.P. Smith Co.
 - b. Clow Valve Co.
 - c. Kennedy Valve Co.
 - d. M&H Valve Co.
8. Electric motor open-shut service operators:
 - a. Rotork.
9. Electric motor operators for throttling service:
 - a. Rotork.
10. Floor Box:
 - a. Clow Valve Co.
 - b. Ludlow.
11. Limit Switches, spring-centered:
 - a. Allen-Bradley.
 - b. Square D Co.
12. T-handle Wrench:
 - a. Clow Valve Co.

2.02 VALVE AND GATE IDENTIFICATION

- A. Each valve and gate shall be tagged with its distinguishing mark letter and number. Mark letter and number will be as listed on Valve Schedule. Identification tag shall be 1-1/2-inch in diameter, 18-gauge polished brass or aluminum with 1/2-inch-high, embossed, black-filled mark letter and number placed thereon. Tags shall be securely fastened to the valve or gate operator with No. 16 brass jack chain or plastic seals.

2.03 COMPONENTS

- A. Industrial Butterfly Valves (IB):
 1. Shall be suitable for installation between ANSI B16.1, Class 125 flanges, and shall be designed for 150 psi working pressure or as herein specified or noted on Valve Schedule. Valves shall meet or exceed the design strength, testing and performance requirements of AWWA Standard C504.

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2. Valve bodies shall be cast iron ASTM A 126, Class B, gray iron ASTM A 48, Class 20 or ductile iron ASTM A 536, Class 65-45-12 or 65-45-15. Valve bodies on exterior valves shall have exposed surfaces protected with a weather-resistant thermosetting multipolymer resin coating.
3. Valve discs shall be ductile iron and, where noted on Valve Schedule, coated with EPDM/EPT. Discs shall be one-piece cast design with no external ribs transverse to the flow. Disc hub and edge shall be ground and polished to a rounded contour to give full concentric seating.
4. Valve seats shall totally encapsulate the inside surfaces of the valve body and shall also serve as the flange gaskets. The resilient elastomer valve seat shall be bonded to metallic or plastic backup ring. Valve seats shall be designed with integral seals at the disc shaft hub areas to completely isolate the stem, stem bearings and body area from the flowing media. Valve seats shall be completely field replaceable at the Site without the use of special tools. Seats shall be Buna N or EPDM/EPT for air.
5. Shafts shall be 316 or 416 stainless steel construction. Valve shafts shall be securely fastened to the valve disc by 316 stainless steel taper pins, or by a broached connection. Shafts shall be provided with both a primary and secondary shaft sealing device at each end of the shaft where the shaft enters the valve body. Upper shaft bearing surfaces shall be adequately designed to absorb the loads imposed by the service conditions and any side thrusts developed by the operator and shall be of the permanently lubricated type for valves 12-inch and smaller and self-lubricating bushing type on valves larger than 12 inches. On valves 30 inches and larger, shaft seals shall be of the double-chevron bi-directional type suitable for both pressure and vacuum. Seals may be pre-loaded by a packing gland mechanism. The packing gland, studs, and nut shall be constructed of corrosion-resistant materials.

B. Resilient Seated Gate Valves (RA):

1. Resilient seated gate valves shall be designed for 150 psi working pressure and shall meet the requirements of AWWA Specification C509 or C515 except as otherwise specified herein. Valves shall be cast or ductile iron body, bronze stem, O-ring stem seal, and non-rising stem. The interior and exterior surfaces of the valve body shall be coated with an epoxy coating meeting the requirements of AWWA C550. The bronze or iron or ductile iron wedge shall be fully encapsulated with molded rubber. No bare metal shall be left exposed. The valve shall seal on both sides of the wedge. Gate valves shall have a clear waterway equivalent in area, when fully open, to that of the connecting pipe. Valves shall be made to open when turned to the left, or counterclockwise. The gate valves shall have square wrench nuts mounted on non-rising stems. All fasteners shall be stainless steel. Ground-buried gate valves shall be furnished with valve boxes. Flanges shall meet the requirements of AWWA C115 (ANSI 21.15). Two complete sets of joint accessories shall be furnished with each valve.
2. The force mains will be laid with a minimum 5 feet of cover or as noted on Drawings. One operating wrench of suitable length shall be provided under this Section.

C. Standard Swing Check Valves (C):

1. Standard swing check valves shall meet the requirements of ANSI/AWWA C508.. Check valves shall be cast or ductile iron body with end flanges conforming to ASME B16.1 Class 125. Resilient to metal type seat shall be provided with stainless steel seating surface mechanically attached to machined body area with the buna-N seat material integral with or mechanically attached to the disc. Check valves shall be of the balanced single disc type with the disc hinged at the top, with outside lever and adjustable weight or spring. A clear waterway opening equal to the full area of the connecting pipe shall be provided when the valve is open.

2. Disc shall be cast or ductile iron.. Hinge pins shall be one piece stainless steel and protrude through both sides of the body. Bronze or stainless steel bushings with adjustable packing or O-ring seal shall be provided where pins pass through the valve body.
 3. Valves shall be interior coated with epoxy meeting requirements NSF/ANSI 61 approved epoxy in accordance with AWWA C550 and, as minimum, be painted with primer on the exterior.
- D. Double Vane Check Valves (DC):
1. Valves shall be of the spring-loaded, double-vane type with flanged ends or suitable for mounting between two flanges. Valves shall be designed for 150 psi working pressure except as herein specified or shown on Valve Schedule. Torsion springs shall be of a heat-resistant material.
 2. Valves shall be furnished with cast iron bodies, bronze mounted, Buna-N seal, nickel-plated steel stops, 316 stainless steel pin and spring and cast iron pin retainer.
- E. Plug Valves (P):
1. Plug valves shall meet the requirements of AWWA C517, be nonlubricated, eccentric type with nitrile butadiene (hycar) or Buna-N resilient faced plugs. End connections shall generally be flanged or grooved for inside valves and mechanical joint for exterior ground-buried valves. Port areas shall be equal to at least 80 percent of the nominal size pipe area. Valve shall be suitably marked to indicate whether it is open or closed.
 2. The seating surface of the valve body shall be welded in stainless steel or nickel. Bearings at the top and bottom supporting the rotating element shall be self-lubricating, corrosion-resistant type, suitable for sewage plant service. The valve shall be of the bolted bonnet design. Packing shall be visible for inspection without dismantling valve or removing operator. The packing shall be adjustable and replaceable without disassembling of the valve and actuator. The valve body shall be cast or ductile iron marked to show seat side of valve.
 3. Plug valves shall be of adequate design to operate with a pressure of 50 psi on both sides or on either side of the valve without leakage.

2.04 VALVE JOINTS

- A. Bell and Spigot Lead: Bell lead joints shall meet the requirements of ANSI/AWWA C110/A21.10.
- B. Flange Joint: Flanges shall meet the requirements of ANSI-B16.1 Standard Class 125, except that bolt holes at shaft hubs may be drilled and tapped on the flanges. Flange faces shall be coated with a rust inhibitor immediately after drilling.
- C. Grooved Coupling: Grooved coupling joints shall be the rigid type and shall have housing fabricated in 2 or more parts of malleable iron in accordance with ASTM Specification A 47, Grade C32510. Ends shall be factory grooved in accordance with the coupling manufacturer's standard groove dimension. Bolts shall be oval neck track head type with hexagonal heavy nuts, per ASTM A 183 and A 194/A 194M. Gasket material shall be Grade H, E chlorinated butyl, or E.P.D.M. for water service and Grade T Buna-N for sewage.
- D. Mechanical joints shall conform to ANSI/AWWA C110/A 21.10 and ANSI/AWWA C111/A 21.11.
- E. Push-on joints shall conform to ANSI A21.11 and AWWA C111.
- F. Screwed joints shall conform to American Standard dimensions ANSI B16.3 and threads ANSI B2.1.

G. Wafer joints shall be flat face or raised face for use between standard flanges.

2.05 ACCESSORIES

A. Manual Operators: Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to the maintenance shall be easily accessible.

1. Manual operators shall be so sized that a maximum of 80 pounds of rim force/pull is required for operation.
2. Positions of operators shall be approved by ENGINEER.
3. Valve shall be made to open when turned to the left or counterclockwise.
4. The direction of the operator to open position shall be indicated on the operator.
5. Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
6. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
7. Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
8. Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
9. Lever shall be fabricated steel, shall include a setscrew and be grease lubricated.
10. Chain lever shall indicate chain and lever. Materials shall be galvanized.
11. Infinite lever shall be of extra heavy steel and capable to be moved to any position and locked in place by a simple wing nut.
12. Position lever shall be of extra heavy steel with a multiple position throttling plate.
13. Wrench heads shall be cast iron with setscrew. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.
14. Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.

B. Motor:

1. Electric Motor Open-Close Service: Electric motor actuators for open-shut service shall meet the requirements of ANSI/AWWA C542, except as herein specified.
 - a. Controls shall be "integrally mounted" as part of the actuator body. If designated on Valve Schedule a "wall-mounted enclosure" or "remote control station" shall be provided for mounting important actuator controls separate from the actuator body in an easily accessible location. Deviations from the Valve Schedule will not be accepted.
 - b. The valve manufacturer shall provide the required seating, unseating dynamic torque requirements and any other trust or static loading information necessary to properly size the electric motor actuator.
 - c. Electrical equipment shall be mounted in a NEMA 4 or 7 enclosure whether on the valve body or in the wall-mounted enclosure. The enclosure shall be NEMA 4 unless shown otherwise on Valve Schedule.
 - d. Actuator materials of construction shall be selected by the manufacturer to be compatible with the environmental conditions that will be present at the valves installed location. Actuators installed in water treatment plants or other potable water applications shall have materials that comply with the Safe Water Drinking Act requirements including food grade lubricants.

- e. Motorized valve actuators shall include the motor, reversing starter with remote-off-local switch, associated gearing, limit switches, torque switches, auxiliary handwheel for manual operation, a valve mounted mechanical dial valve position indicator, Open-Close-Stop position switch or push-buttons, and accessories as listed on Valve Schedule.
- f. The remote control station shall be provided by the actuator manufacturer, have a NEMA 4 rated enclosure unless noted otherwise on Schedule and be powered by the actuator. Signal and power wires shall be integrally linked to the actuator with wires landed on appropriately marked terminal strips in the actuator. Unit shall be capable of being mounted 300 feet away from the actuator and with enclosure suitable for wall, rack or pole mounting. Locable Local-Off-Remote selector and Open-Close valve position switches, push buttons, and open-closed indicator lights or valve position indication shall be provided.
- g. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
- h. The motor starters shall be the solid state reversing contactor type complete with gang-operated switch, 2 solid state reversing contactors, 120 volt control power transformer when motor voltage is other than 120 volt, thermal overload protection for each phase, and associated wiring. Operating voltage shall be 460 Volts unless indicated otherwise on Valve Schedule.
- i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for the local indicator lights and interlocking. An additional 4 switches shall be provided for remote use.
- j. Torque switches shall be provided in both the open and closed circuits of the operators. The torque switches shall be field adjustable and designed to stop the operator motor when the torque exceeds safe limits for either the operator or the valve. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque seated valve.
- k. A local mechanical dial position indicator shall be provided on the valve operator to indicate the position of the valve.
- l. Motors shall be standard-duty rated, totally enclosed nonventilated, Class B insulated, 60 hertz and specially designed for valve service. If voltage and phase are not noted on Valve Schedule configure motors for 460 Volt three phase service. The design shall combine low inertia with a high starting and stalling torque.
- m. Lost motion drive for increased unseating torque shall be provided.
- n. Unless indicated otherwise on Valve Schedule the actuator shall be sized to stroke valves from full open to full closed and vice versa in one to three minutes under the full specified unbalance operating head stated in the Specifications and at a frequency not to exceed 60 cycles per hour. The motor winding temperature rise shall be NEMA standard for Class B insulation at the rated service factor load.
- o. Gear case shall be cast iron. Pedestals shall be fabricated steel or cast iron. Stem nut shall be high-tensile bronze.
- p. A heater shall be provided if indicated in the Schedule to prevent condensation in the controls cavity and terminal chamber of the actuator body. Heaters shall be 120 V powered. Multiple heaters shall be provided if necessary depending on the actuator body configuration.

- q. Mechanical manual operation shall be provided by a clutchable handwheel drive mechanism completely independent from the motor gearing. Hand operation shall be direct drive permitting fast manual valve operation. Failure of motor gearing due to power failure or gearing problem shall not prevent handwheel operation. Manual operation shall prevent (disconnect) electrical operation. Gear reducers shall be provided for manual handwheel if required. Maximum rim force required for handwheel operation shall not exceed 40 pounds for dynamic loads. Manual operator shall engage the actuators lost motion device.
- 2. Electric Motor Throttling Service:
 - a. Electric motor actuator for throttling service on the valves shall meet the requirements of ANSI/AWWA C542 except as herein specified. Enclosures shall be NEMA 4 unless shown otherwise on Valve Schedule.
 - b. The valve operator torque shall be as required for a 150 psi pressure drop across the valve, minimum, except those for low pressure air service. The valve operator torque for low pressure air service valves shall be as required for a 25 psi pressure drop across the valve, minimum.
 - c. The valve manufacturer shall provide the operating seating, unseating and dynamic torque requirements along with any other thrust or static loading information necessary to properly size the electric motor actuator.
 - d. Actuator materials of construction shall be selected by the manufacturer to be compatible with the environmental conditions that will be present at the valves installed location. Actuators installed in water treatment plants or other potable water applications shall have materials that comply with the Safe Water Drinking Act requirements including food grade lubricants.
 - e. Mechanical parts shall be designed for safety factor of at least 2. Construction of the operator shall be such that it may be mounted in any position required to facilitate manual operation. Manual operation of the valves shall be possible by a handwheel attached to the mechanism. Power to motor circuit shall be automatically disconnected to prevent accidental electric operation during manual operation. A mechanical dial position indicator shall be provided to continuously indicate valve position. Operator bearings shall be self-lubricating type or lubricated for life before operator is sealed at the factory.
 - f. The operator motor shall be heavy-duty with continuous duty rating and totally enclosed and nonventilated. The motor shall be equipped with thermal overload protection. Operating voltage shall be as listed on Valve Schedule.
 - g. The winding temperature rise shall meet NEMA standard for the class of insulation used at the rated service factor load. The motor shall be for high torque variable speed duty. The motor shall be reversible. A 4-20 mA throttling signal shall be provided by others. Control interface electronics, motor controller, and appurtenances to accept this signal and position the valve between 0 and 90 degrees based on the value of the throttling signal shall be provided with the valve operator. The controller shall be provided complete with NEMA 4 enclosure, Auto-Manual selector switch and Open, Close push-buttons. Controller shall be completely solid state; contactors are not acceptable. Motor and controller shall be suitable for 600 starts per hour. Controllers shall accept an isolated 4-20 mA signal for valve positioning from a remote source. Valve operators shall be equipped to be field adjustable to fail open, fail closed, or fail in place upon loss of control signal (4-20 mA). Actuators shall be set up to fail in place unless otherwise noted on Valve Schedule.
 - h. The actuator motor gear train in conjunction with any gearing provided as part of the valve shall be pre-selected to have a stroking time from open to close or vice versa between 1 and 3 minutes or as shown on Valve Schedule.
 - i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as

standard for a local indicator and interlocking. An additional switch shall be provided at each end for remote use.

- j. Motor circuit limit switches shall be of the direct break type. Limit switches shall be adjustable. Limit switch contacts shall be isolated. Auxiliary switches for secondary functions shall be of the cam-operated, spring leaf type. The operator shall be equipped with a torque switch for protection in the closing direction. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque-seated valve. In the event of power failure, the operator shall lock in the last control position until power is restored or switched over to standby power or the manual operating handwheel is engaged.
 - k. Torque switches, limit switches, and motor thermal switches are to be mounted as required inside the housing and connected to the master terminal strip. Provisions shall be made for 2 internal potentiometers for feedback control operations and for remote valve position indicator. Wiring within operator shall be incorporated in a standard laced wiring harness using compression connectors and terminal strips. Internal wiring shall be UL approved for 105 degrees C operation. Insulation shall be suitable for 600 volts.
 - l. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
3. Electric Motor Actuator Retrofit.
- a. Existing valves shall be retrofitted with new motor actuators when shown on the Valve Schedule.
 - b. Prior to submitting shop drawings the actuator manufactures representative shall perform a field inspection to verify mounting requirements and existing configurations that may effect valve mounting.
 - c. If the existing valve and operator need to be partially disassembled or operated through open-close cycles to acquire the necessary information for installation of new actuators the Engineer and Owner shall be notified in advance to allow time for scheduling.
 - d. Actuator representative is responsible to either contact the existing valve manufacturer to obtain torque requirements. If this information is not available loadings shall be as determined by the actuator manufacturer based on field observation and measurements of existing actuator and ancillary support utilities, historical data of similar valves or other means. Actuator manufacturer shall assume increased torque will be required for old valves and make allowances when sizing new actuators.
 - e. Adapter plates, bushings, couplings, mounting brackets, secondary gear assemblies and any other items necessary for proper actuator mounting shall be provided. If not indicated otherwise materials shall be compatible with the environment at the mounting location.
 - f. Actuator representative shall perform installation and start-up site visits to ensure the actuators are functioning properly and communicating with the control system.
 - 1) Actuator representative shall configure the valve including setting the open/close limits and seating/unseating torque settings. All settings shall be carefully adjusted to avoid overloading existing valve components.
 - 2) Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.

C. Bench Stand: Bench stands shall meet the requirements of floor stands as specified in this Section, except that baseplates shall replace pedestals.

- D. Remote Control Station: The control package shall consist of indicating lights, Open-Close-Stop push-button stations, Local-Remote control selector, strip headers, and wiring factory assembled, mounted in a NEMA 4 enclosure unless otherwise noted on Valve Schedule.
- E. Extension Bonnet (Length): Extension bonnets shall be cast iron and be provided complete with galvanized assembly bolts.
- F. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
 - 1. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.
- G. Floor Box (Length): Where openings through concrete slabs are provided for key operation of valves and extension stems connected therewith, the operating nut being in or below the slab, such openings shall be provided with a floor box, complete with cover. Each floor box shall be of the depth required for installation as shown on Valve Schedule and shall have cast on the cover an appropriate name designating the service for which the valve is used. In addition, where the operating nut is in the slab, the floor box shall be bronze bushed; where below, the opening in the bottom of the box shall be sufficient for passage of the operating key.
 - 1. Each floor box and cover therefor shall be coated by dipping in hot asphaltum varnish.
- H. Floor Stand: Floor stands shall meet the requirements of AWWA C501 for Manual Operating Mechanism except as specified in this Section.
 - 1. Floor stands shall be a high-strength cast iron pedestal type furnished with lubrication fittings and stainless steel, double-nutted anchor bolts.
 - 2. Geared floor stands shall have weatherproof housings.
 - 3. Floor stands shall be provided with a galvanized steel stem cover and position indicator, and the direction of rotation to open the valve shall be indicated.
 - 4. The operating stem will be 304 or 303 stainless steel.
 - 5. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand.
- I. Position Indicator: Position indicators shall be of bronze or cast iron construction.
 - 1. Limit Switch. Two limit switches shall be factory-mounted to the valve for indicating full open and full closed positions.
- J. Manual Screw: Manual screw operators shall meet the requirements of AWWA C504 operators.
- K. Remote Position Indicator: Remote position indicators shall be the isolated 1,000 ohm potentiometer design for use with a remote position indicator. Resolution of 1/2 percent shall be required and potentiometer shall be directly attached to or geared from the valve operating shaft.
- L. Stem Cover: Stem covers shall be galvanized steel with position indicators and cap.
- M. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B, construction with bronze bushings adjustable in two directions and provided with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.

- N. Valve Box (Length): Valve boxes shall be either cast iron or ABS plastic. Cast iron lids shall be provided with valve boxes and shall be marked "WATER" in raised letters.
1. Cast iron boxes shall be of the 3-piece adjustable type. A Number 6 base shall be furnished with valves 8 inches or less, and a Number 160 base shall be provided for valves over 8 inches.
 2. ABS plastic boxes shall be of high-grade ABS polymer, two sections, adjustable to varying, desired grade levels by means of a friction design (upper section slides inside lower section), with base to fit various sized valves with arch.
 3. Plastic material shall meet requirements of ASTM D 1788.
 4. Cast iron material shall meet requirements of ASTM A 126-B or ASTM A 48, Class 30B.
 5. Bolt material shall meet requirements of ASTM B 316 and B 253.
 6. A magnet shall be permanently molded into both the upper and lower sections for easy locating with a dip needle or magnetic locator.
- O. Wall Bracket: Wall brackets shall be cast iron and provided with stainless steel assembly and anchor bolts.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.
- B. Equipment furnished under this Section shall be installed under Section 15100.

3.02 FIELD QUALITY CONTROL

- A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section are installed in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 15115 - PLUMBING VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General duty valves common to most mechanical piping systems.
- B. Refer to system specifications for valves to be used for a given service. Then use the following tables for a complete description of each type of valve.
- C. Special purpose valves are specified in individual piping system specifications.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.
 - 1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B31.9, "Building Services Piping."
 - 2. ASME B31.1, "Power Piping."
- B. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves for shipping as follows:
 - 1. Ensure valves are dry and internally protected against rusting and corrosion.
 - 2. Protect valve ends against damage to threads, flange faces, and weld ends preps.
 - 3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage:
 - 1. Do not remove valve end protectors, unless necessary for inspection then reinstall for storage.
 - 2. Protect valves from weather; store valves indoors. Maintain valve temperature higher than the ambient dewpoint temperature. If outdoor storage is necessary, support valves off the ground or on pavement in watertight enclosures.
- C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work are listed in the valve Schedules.

2.02 VALVE FEATURES

- A. Valve Design: Rising stem or rising outside screw and yoke stems.
 - 1. Nonrising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Same sizes as upstream pipe, unless otherwise indicated.
- D. Operators: Provide the following special operator features:
 - 1. Handwheels, fastened to valve stem, for valves other than quarter turn.
 - 2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
 - 3. Chainwheel operators, for valves 2-1/2-inch and larger, install 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
 - 4. Gear driven operators, on quarter-turn valves 8-inch and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. End Connections: As indicated in the valve specifications.
 - 1. Threads: Comply with ANSI B1.20.1.
 - 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
 - 3. Solder-Joint: Comply with ANSI B16.18. Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.

GATE VALVES (101)

Subsection Number	Valve Size	Specifications
101.1	1/4" - 2"	Bronze, Class 125 (200 WOG, screwed, RS, split wedge, union bonnet. C-430 UB, J-62U, L-3125, P- 2700, S-B-106 (Class 125), S-B-121 (Class 150).
	2-1/2" - 16"	IBBM, Class 125 (200 WOG), flanged, RS, solid wedge, bolted bonnet. C-465-1/2, J-651-A, L-1430, P-1793, S-G-623.
101.2	1/4" - 1-1/2"	Bronze, 200-pound class, screwed body, RS, solid wedge, union bonnet. C-424, J-270U, L- 2227, P-2375-S, S-B-132.
	2" - 16"	IBBM, Class 125 (200 WOG), flanged, RS, solid wedge, bolted bonnet. C-465-1/2, J-651-A, L-1430, P-1793, S-G-623.
101.3	1/4" - 1-1/2"	Bronze, 200-pound class, screwed body, RS, solid wedge, union bonnet. C-424, J-270U, L- 2227, P-2375-S, S-B-132.
	2" - 24"	Cast steel, Class 150, RS, solid or flexible wedge, bolted bonnet. Use weld end body except where hazardous environment precludes welding or when replacing Class 125 valve to handle higher service conditions. W.E. Valves: C-47-1/2 XU-F for 2" - 16", C-47-1/2 XU for 18"-24", J-2009-B8F, L-1513, P-1503-N W.E. for 2"-12", P-1503 W.E. for 14"-24", S-15-OW- U for 2"-12", S-15-OW-11 for 14"-24" Flanged Valves: C-47XU-F for 2"-16", C47XU for 18"-24", J-1009-B8F, L-1502, P-1503-N F.E. for 2"- 12", P-1503 F.E. for 14"-24", S-15-OF-U for 2"-12", S-15-OF- 11 for 14"-24".

BALL VALVES (104)

Subsection Number	Valve Size	Specifications
104.8	1/4" - 2"	Stainless steel, screwed, blow-out proof stem, Teflon seats and seals. Consolidated Brass "Apollo" series 76, Crane 950-TF, Jenkins 1350, Jamesbury 11-3600MT, Whitey "60" Series.

NOTES: 1. Round or oval handles are available from most manufacturers and should be considered where a valve may be subject to accidental operation or may cause personnel injury.

HOSE BIBB/WALL HYDRANT (109)

Subsection Number	Valve Size	Specifications
109.3	1-1/2"	Flushing hose bibb, 125-pound, bronze gate valve with fire hose thread and protective cap with chain.
109.5	3/4" - 2"	Corporation cock, 125-pound, solid head, plain top, flared coupling, per AWWA C800. Ford Meter Box Company.

CHECK VALVES (110)

Subsection Number	Valve Size	Specifications

CHECK VALVES (110)

Subsection Number	Valve Size	Specifications
110.5	1/2" through 6"	Stainless steel, Class 150, swing check, Teflon seat and seals, Flanged ends. Crane 61676-BB series or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion.
- B. Examine mating flange faces for conditions which might cause leakage. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- C. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- D. Replace defective valves with new valves.

3.02 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Steel Pipes Sizes, 2-Inch and Smaller: threaded or grooved end.
 - 2. Steel Pipe Sizes 2-1/2-Inch and Larger: grooved end or flanged.

3.03 VALVE INSTALLATIONS

- A. General Application: Ball valves in sizes 2-inch and smaller, and butterfly valves in sizes 2-1/2-inch and larger, are to be used unless gate or globe valves are specifically designated on Drawings. Refer to piping system specification sections for specific valve applications and arrangements.
- B. Locate valves for easy access and provide separate support.
- C. Install valves and unions for each fixture and item of equipment to allow equipment removal without system shut down. Unions are not required on flanged devices.
- D. Install valves in horizontal piping with stem at or above the center of the pipe.
- E. Install valves in a position to allow full stem movement.

3.04 FIELD QUALITY CONTROL

- A. After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.05 ADJUSTING AND CLEANING

- A. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

END OF SECTION

SECTION 15125 - METERS, GAUGES, SWITCHES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pressure Gauges.

1.02 SUBMITTALS

- A. Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.
 - 1. Product data for each type of device: Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
 - 2. Product certificates signed by manufacturers of meters and gauges certifying accuracies under specified operating conditions and products' compliance with specified requirements.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operating and maintenance manuals for items included under this Section..

1.03 QUALITY ASSURANCE

- A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
- B. ASME, ANSI, and ISA Compliance: Comply with applicable portions of ASME, ANSI, and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pressure Gauge:
 - a. Ashcroft, Model Type 1279.
 - b. Terice, Model No. 450LFB.
 - c. Weksler "Royal AY14."

2.02 MATERIALS

- A. Pressure Gauge: Pressure gauges shall be liquid filled with a fiberglass-reinforced polypopylene case and ring, 4-1/2-inch steel dial with white background and black markings, clear glass window, micro-adjustable aluminum pointer with black finish, brass movement with milled teeth, bourdon tube of drawn Grade A phosphor bronze with silver brazed joints, and a 1/4-inch NPT brass bottom outlet with shutoff valve.

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1. Accuracy shall be 1/2 percent of full scale, meeting ASME Grade 2A B40.1.
2. Scale range shall be 0 to 100 psi unless noted on Drawings.
3. Seals shall be provided for all non-clean water applications. Seals and diaphragms shall be suitable for the service provided.
4. Provide protective siphon when used for steam service.

PART 3 - EXECUTION

3.01 INSTALLATION OF PRESSURE GAUGES

- A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.
- B. Install in the following locations, and elsewhere as shown on Drawings:
 1. At each pump.
 2. At discharge of each pressure-reducing valve.
 3. At building water service entrance.

3.02 INSTALLATION OF TEST PLUGS

- A. Test Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.03 ADJUSTING AND CLEANING

- A. Adjust faces of meters and gauges to proper angle for best visibility.
- B. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Sections of Division 15. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 1. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION

SECTION 15140 - WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Water Distribution Piping System:
 - a. Potable cold and hot, water system.
 - b. Non-Potable cold water system.
 - 2. Service Water Distribution System.
 - a. Plant effluent water distribution system.
 - b. Piping, fittings, and specialties.

1.02 DEFINITIONS

- A. Water Distribution Piping: A pipe within the building or on the premises which conveys water from the water service pipe, or meter, to the points of usage. This definition includes all potable, Non-potable, service, and effluent water piping.
- B. Potable Water Piping: The pipe from the water main, or other source of potable water supply, to the water distributing system of the building served.
- C. Service Water Piping: A pipe within the building or on the premises which conveys service water to the points of usage.
- D. Effluent Water Piping: A pipe within the building or on the premises which conveys plant effluent water to the points of usage.
- E. Non-Potable Water: A pipe within the building or on the premises which conveys water which has been separated from the potable water service by means of backflow prevention device. This water shall not be used for human consumption, hand washing, bathing, drinking, food preparation, or cleaning of equipment or articles used in preparation or consumption of food or drink.
- F. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- G. Abbreviations used within this specification
 - 1. PW: Potable Water (also referred to as cold water or city water)
 - 2. NPW: Non-Potable Water
 - 3. PEW: Plant Effluent Water
 - 4. HW: Hot Water
 - 5. SW: Service Water (also referred to as NPW)

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section:
 - 1. Product data for each piping specialty and valve specified.

2. Welders' Certificates certifying that welders comply with requirements specified in Quality Assurance below.
 3. Certification of Compliance with ASME and UL fabrication requirements specified below.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section..
- C. Test and Inspection Report: Submit a written report to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure valves shall bear the appropriate ASME label.
 2. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
 3. Michigan Plumbing Code.

1.05 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.06 EXTRA STOCK

- A. Maintenance Stock: Furnish one valve key for each key-operated hydrant, bibb, or faucet installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Yard Hydrants:
 - a. Josam Manufacturing Co.
 - b. Woodford.
 - c. Zurn.
 2. In-Line Pressure Relief Valve:
 - a. Bailey.
 - b. Baker.
 - c. Cla-Val Co.
 3. Pressure Reducing Valve:
 - a. Cla-Val Co.
 - b. Golden Anderson.

4. Backflow Preventer:
 - a. Cla-Val Co.
 - b. Febco Sales, Inc., Subs. of Charles M. Bailey Co., Inc.
 - c. Hersey Products, Inc.
 - d. ITT Lawler, Fluid Handling Division.
 - e. Watts Regulator Co.
5. Backflow Preventer Test Kit:
 - a. Mid-west Instrument, Model 830.
6. Pressure Regulating Valve:
 - a. Cla-Val Co.
 - b. Masonelian.
7. Relief Valve:
 - a. Cash (A.W.) Valve Manufacturing Corp.
 - b. Conbraco Industries, Inc.
 - c. Watts Regulator Co.
 - d. Zurn Industries, Inc., Wilkins Regulator Division.
8. Water Hammer Arrester:
 - a. Josam.
 - b. Wade.
9. Pressure Gauge:
 - a. Terice, Model No. 450LFB.
 - b. Ashcroft, Model Type 1279.
10. Hose:
 - a. B.F. Goodrich.
 - b. Uniroyal.
11. Flushing Hose:
 - a. B.F. Goodrich.
 - b. National Fire Hose.
 - c. Uniroyal.
12. Y-Pattern Strainer:
 - a. Armstrong Machine Works.
 - b. Hoffman Specialty ITT, Fluid Handling Division.
 - c. Spirax Sarco.
 - d. Trane Co.
 - e. Victaulic Co. of America (low-pressure applications only).
 - f. Watts Regulator Co.
13. Dual Basket Strainer
 - a. Eaton 53 BTX
14. Hose Reels:
 - a. Ames.
 - b. Suncast.

2.02 MATERIALS

- A. Following are material specifications for the water systems. Refer to Section 15105 and Section 15115 for specifications listed below.

Item	Spec. No.	Remarks
Piping PEW and PW – Buried or exposed 3-inch and larger	62.5	DIP
PW and NPW Exposed 3-inch and larger	61.10	Galv. Steel
	66.1	Stainless Steel (corrosive areas)
PW and NPW Buried 2-1/2 inch and smaller	63.1	Copper
PW and NPW Exposed 2-1/2 inch and smaller	63.4	Copper PVC Coated
Alternate	66.1	Stainless Steel (corrosive areas)
PEW, PW, NPW Ball Valves 1/2 inch – 2 inch	104.8	Stainless Steel, Steel, DIP, or Copper
	104.2	Copper piping
PEW, Ball Valves, Flanged 2-1/2 – 12 inch	104.12	Stainless Steel, Steel, DIP, or Copper
Check Valves	110.1	
Globe Valves	105.1	
Hose Bibbs/Cocks/Stops	109	See 109 series

2.03 SPECIAL DUTY VALVES

- A. Tempering Valve: Bronze body and plunger, hermetically sealed thermostatic element, mixing range from 100 to 140 degrees F. Provide valve with isolation valves and temperature gauge.
- B. Relief Valves: Provide proper size for relief valve, in accordance with ASME Boiler and Pressure Vessel Codes, for indicated capacity of the appliance for which installed.
- C. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F, and pressure relief at 150 psi.

- D. In-Line Pressure Relief Valve: Valve shall maintain constant upstream pressure by bypassing or relieving excess pressure, and shall maintain close pressure limits without causing surges. The main valve shall be of the hydraulically operated, pilot-controlled diaphragm type, and shall have a single removable seat and resilient disc with external strainer. No external packing glands shall be allowed, and the diaphragm shall not be used as a seating surface. The pilot control shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds spring setting. As excess line pressure is dissipated the main valve shall gradually close to a positive, drip-tight seating.
- E. Pressure Reducing Valve (PRV) and Pressure Control Valves (PCV): Pressure reducing valves shall maintain a constant downstream pressure regardless of varying inlet pressure. Valves shall be globe pattern or angle pattern as required by the installation shown on Drawings and/or as called for on Schedule.
1. Valves shall be hydraulically operated, pilot-controlled and of the diaphragm-operated type; the diaphragm shall be nylon fabric-reinforced synthetic rubber and the disc shall have a rectangular cross-section. The valve may also be a self-contained differential piston type with the small end of the piston representing one of the sealing contacts, and the large end representing the effective area to provide the closing force.
 2. The external pilot valves and piping shall be arranged for either pressure sustaining or pressure reducing service for the pressure range as listed on Schedule. The pilot control shall be direct-acting, adjustable, spring-loaded, diaphragm type.
 3. Valves shall be cast iron or semi-steel body with bronze trim and be designed for 150 psi working pressures. Valves shall be fitted with renewable seals and designed so that the seats can be replaced without removing the valve from the piping. Valves shall be furnished with a valve position indicator, flow stabilizer, shutoff valves and a strainer in the pilot system. Flow symbols shall be cast in the valve body or the inlet end shall be identified to facilitate correct installation in the piping. Valve shall have ANSI 125-pound flanged connections.
- F. Yard hydrants shall be the nonfreezing type, with a connection and depth of bury as noted on Drawings. Provide hydrants with curb stop and valve box conforming to Valve Schedule No. 109.4 in Section 15110. Hydrants shall be located where shown on Drawings and indicated on Schedule.

2.04 PIPING SPECIALTIES

- A. Water Hammer Arresters: Bellows type, with stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- B. Y-Strainers: 1/4-inch through 2-inch, bronze, screwed, 250-pound or 300-pound ASTM A 61 or A 62 with stainless steel or monel screen having 3/64-inch perforations.
- C. Basket Strainers: 2-1/2-inch and larger cast iron, flanged, duplex basket strainer with stainless steel screen basket having 1/8-inch perforations and 200 mesh 316 stainless steel insert. Strainer shall have drain for each basket.
- D. Non-Freeze Post Hydrants: Cast-bronze hydrant, with tee handle key, drain hole, vacuum breaker, 3/4-inch inlet and hose outlet. Bronze casing with cast-iron casing guard shall be length to suit depth of bury.
- E. Backflow Preventers: Reduced pressure principle assembly consisting of shutoff valves on inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve

located between two positive seating check valves, and comply with requirements of ASSE Standard 1013.

1. Operation shall be completely automatic. All parts must be removable or replaceable without removal of the unit from the line. The total head loss through the complete backflow assembly shall not exceed 15 psi at the rated flow listed in the Schedule.
 2. Main valve body and cover shall be bronze ASTM B 61 or cast iron ASTM A 26 interior epoxy coated, main valve trim to be bronze ASTM B 61 and differential relief valve shall be bronze ASTM B 61 with 304 stainless steel trim. Two isolating gate valves and air gap drain fitting shall be included.
 3. A test kit shall be furnished incorporating a differential pressure gauge and appropriate valving and hoses for easy field hookup. The unit shall be capable of a working pressure to 175 psig and working temperature to 200 degrees F. The gauge dial shall be 0-15 psig with 1-pound major graduations and 0.2-pound minor graduations.
 - a. Hose lengths shall be at least 3 feet, colors matched to valves, and shall have hose end fittings 1/4-inch female quick couplers. The kit shall include a set of brass adapters if required for the backflow preventer supplied.
 4. Provide a spare parts kit for each size of backflow preventer supplied.
- F. Pressure Regulators: Single-seated, direct-operated type having bronze body with integral strainer, and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and inlet and outlet pressures indicated.
1. Regulator shall have maximum initial pressure limit of 100 psi, and a reduced pressure range of 5 to 35 psi. An adjusting screw shall be easily accessible for changing the outlet pressure. Valve seat shall be stainless steel, diaphragm shall be Buna-N.
- G. Pressure Gauge: Pressure gauges shall be liquid filled with a fiberglass-reinforced polypropylene case and ring, 4-1/2-inch steel dial with white background and black markings, clear glass window, aluminum pointer with black finish, brass movement with milled teeth, bourdon tube of drawn grade A phosphor bronze with silver-brazed joints, and a 1/2-inch NPT brass bottom outlet with shutoff valve. Accuracy shall be 1/2 percent of full scale. Scale range shall be 0 to 100 psi unless noted otherwise. Seals shall be provided for all non-clean water applications. Seals and diaphragms shall be suitable for the service provided.
- H. Hose: A 50-foot length of 3/4-inch commercial-duty reinforced rubber hose with garden hose connections shall be provided at each hose station shown on Drawings. Hose shall be capable of handling extensive hot water (200 degrees F) use. Rubber cover shall be resistant to oils, chemicals, abrasion, and weather and have a 600 psi burst pressure. Provide heavy-duty, 175-foot capacity, wall-mounted plastic hose storage reel with hose guide at each hose station location. Hose storage reel shall come with a minimum 3-foot connecting hose to the hose bib.
- I. Flushing Hose: One-hundred-foot lengths of 1-1/2-inch collapsible fire hose for a 300 psi working pressure shall be furnished in the number and locations as noted on Schedule. Adjustable fire nozzles and connectors for hookup to flushing connections shall be provided with each length of flushing hose. Hoses shall be 100 percent synthetic, and resistant to mildew and rot. Provide a heavy-duty wall-mounted storage reel, as recommended by the manufacturer, to be mounted in each of the locations noted.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PIPING INSTALLATION

- A. Install piping with 1/32-inch per foot (1/4 percent) downward slope towards drain point.
- B. Ductile Iron Pipe: Install in accordance with AWWA C60.

3.03 HANGERS AND SUPPORTS

- A. Hanger, supports, and anchor devices are specified in Section 15060. Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs.
- C. Install hangers with the following rod sizes and maximum spacing:

<u>Nominal Pipe Size</u>	<u>Max. Span Feet</u>	<u>Min. Rod Size Inches</u>
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8

- D. Support vertical runs at each floor.

3.04 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering.
2. Fill the tubing and fittings during soldering with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints to proper and uniform temperature.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads.

3.05 SERVICE ENTRANCE

- A. Extend water distribution piping to connect to water service piping, of size and in location for service entrance to building.
- B. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.
- C. Install shutoff valve at service entrance inside building.

3.06 VALVE APPLICATIONS

- A. General Duty Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
 1. Shut-off duty: Use gate, ball, and butterfly valves.
 2. Throttling duty: Use globe and butterfly valves.

3.07 INSTALLATION OF VALVES

- A. Install sectional valves on each branch and riser, close to main, where branch or riser serves two or more plumbing fixtures or equipment connections, and elsewhere as indicated.
- B. Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.
- C. Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.
- D. Install swing check valves on discharge side of each pump, and elsewhere as indicated.
- E. Install balance cocks in each hot water recirculating loop, and elsewhere as indicated.

3.08 INSTALLATION OF PIPING SPECIALTIES

- A. Install backflow preventers in compliance with the plumbing code and authority having jurisdiction. Pipe relief outlet without valves to nearest floor drain or equipment drain.
- B. Install pressure regulating valves with inlet and outlet shutoff valves, and balance cock bypass. Install pressure gauge on valve outlet.

3.09 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.
- B. Mechanical Equipment Connections: Connect hot, cold, service or plant effluent water piping to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2-inch and larger, use flanges instead of unions.
- C. Service and Effluent Water Connections: At each sill cock, hose bibb, and hydrant, a sign shall be placed and shall read in 1-inch-high letters as follows: THIS WATER NOT SAFE FOR DRINKING.
- D. Sealing Water Connections: Sealing water shall be brought to connections on pumps where shown on Drawings. Each connection shall be provided with a throttling valve, wye-strainer, solenoid-operated valve, and shutoff valve as shown on Drawings.
- E. Pressure Reducing Station: Sealing water pressure reducing stations shall be provided in the number and locations shown on Drawings. Each reducing station shall be provided with a shutoff valve, check valve, wye-strainer, pressure regulator, and pressure gauge as shown on Drawings.
- F. Flushing Connections: Where called for on Drawings, a valved flushing connection shall be furnished. The connection shall consist of a threaded pipe and valve suitable for hookup to the flushing hose. The connection shall be made of 1-1/2-inch diameter pipe unless otherwise noted on Drawings.
- G. Foam Suppression Nozzles: Nozzles shall be of one-piece all stainless steel construction. Nozzle shall have a flat fan type spray pattern with fine atomization characteristics and uniform distribution throughout the pattern. Spray angle shall be 110 degrees. Nozzle shall be designed to handle approximately 3.0 gpm at 40 psi, and have a minimum orifice diameter of 5/32-inch.

3.10 FIELD QUALITY CONTROL

- A. Inspect water distribution piping as follows:
 - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in, after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - 3. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 - 4. Prepare inspection reports, signed by the plumbing official.

- B. Test water distribution piping as follows:
1. Test for leaks and defects of all new water distribution piping systems and parts of existing systems which have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 3. Cap, and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of four hours. Leaks and loss in test pressure constitute defects which must be repaired.
 4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
 5. Prepare reports for all tests and required corrective action.

3.11 ADJUSTING AND CLEANING

- A. Clean and disinfect potable water distribution piping as follows:
1. Purge all new water distribution piping systems and parts of existing systems which have been altered, extended, or repaired prior to use.
 2. Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in AWWA C651.
- B. Prepare reports for all purging and disinfecting activities.

3.12 COMMISSIONING

- A. Fill the system.
- B. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
1. Open valves to full open position. Close drain valves, hydrants, and sill cocks.
 2. Remove and clean strainers.
 3. Lubricate pump motors and bearings (where required).

END OF SECTION

SECTION 15150 - DRAINAGE AND VENT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Building sanitary and storm drainage and vent piping systems, including drains and drainage specialties.

1.02 DEFINITIONS

- A. Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section for the following products:
 - 1. Drainage piping specialties.
 - 2. Floor drains.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. Michigan Plumbing Code

1.05 SEQUENCING AND SCHEDULING

- A. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.
- B. Coordinate the installation of sanitary and storm sewer systems as necessary to interface building drains with drainage piping systems.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Drainage Piping Specialties, including backwater valves, expansion joints, drains, trap primers, and vandal-proof vent caps:
 - a. Josam Manufacturing Co.
 - b. Smith (Jay R) Manufacturing Co.
 - c. Tyler Pipe; Subs. of Tyler Corp.
 - d. Wade
 - e. Zurn Industries, Inc; Hydromechanics Division.

2.02 MATERIALS

- A. Unless otherwise noted, pipe materials shall conform to the following specifications. Refer to Section 15105 for piping and Section 15115 for valves listed below:

<u>Item</u>	<u>Spec. No.</u>	<u>Remarks</u>
Sanitary waste and storm piping (exposed)	62.2	C.I.
Sanitary waste and storm piping (finished area)	62.2	C.I.
Equipment Drains (acid)	64.1	PVC – Sch 80

2.03 DRAINAGE PIPING SPECIALTIES

- A. Floor Cleanouts: Furnish and install cleanouts where indicated on Drawings at all bends, angles, upper terminals and not over 50 feet apart. All cleanouts shall have bronze countersunk rectangular slotted plugs lubricated with nonhardening thread lubricant and flush-with-floor, heavy-duty cast iron cleanout tops with nonskid covers. Flashing flange is required on membrane floors. Provide extra heavy nickel bronze tops in tiled floor areas.
- B. Wall Cleanouts: Cast iron body adaptable to pipe with cast bronze or brass cleanout plug; stainless steel cover including screws.
- C. Flashing Flanges: Cast iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.
- D. Vent Flashing Sleeves: Cast iron caulking type roof coupling for cast iron stacks, cast iron threaded type roof coupling for steel stacks, and cast bronze stack flashing sleeve for copper tubing.
- E. Frost-Proof Vent Caps: Construct of galvanized iron, copper, or lead-coated copper, sized to provide 1 inch air space between outside of vent pipe and inside of flashing collar extension.

2.04 FLOOR DRAINS

- A. Provide cast iron, round floor drains having a minimum of 30 square inch free grate area. Provide with double drainage flange. Rectangular floor drains shall have a minimum of 14 square inch free grate area. Connections shall be screwed, hub or inside caulked as required by the particular location. All sanitary system floor drains shall be trapped. Rectangular type used near walls only.
 - 1. Floor Drains, Tiled Floor Areas: Square drains shall have a minimum of 9 square inch of free grate area, with flashing collar, and adjustable nickel bronze strainer. All drains shall be trapped. Connections shall be screened, hub or inside caulked.
 - 2. Floor Drains, Acid Waste Drainage: Drain shall be made of the same material as specified for piping with flashing collar and adjustable strainer.
 - 3. Floor Drains, Garage and Grit Area: Drain shall be coated cast iron with double drainage flange, weepholes, bottom outlet inside caulk connection, round top, loose set heavy-duty grate with minimum of 28.5 square inches of free area, and removable sediment bucket. Drains shall be used in areas where vehicular traffic or other grit producing activities exist.
- B. Equipment drains shall consist of a trapped pipe hub outlet located approximately 2 inches above finished floor.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
- C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
- D. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Drainage connections shall be provided from the floor drainage system to the equipment as shown on Drawings. Reducing couplings shall be used to fit the equipment outlets provided. All future equipment outlets shall be provided with a plug.
- B. No exposed drainage pipe, for any purpose, shall be less than 1-1/2 inches in diameter, and ground-buried less than 3 inches in diameter. The ends of all runs and the bases of all stacks shall be provided with cleanout extensions stopped with brass plugs. All drainage lines shall be properly trapped and be adequately pitched toward the outlet.
- C. All drainage systems under foundation footings shall be encased in concrete.
- D. Make changes in direction for drainage and vent piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and

have a common drain. Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

- E. Install underground building drains to conform with the Plumbing Code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag-in line and pull past each joint as it is completed.
- F. Install building drain pitched down at minimum slope of 1/4-inch per foot (2 percent) for piping 3-inch and smaller, and 1/8-inch per foot (1 percent) for drainage piping 4-inch and larger.
- G. Extend building drain to connect to sewer piping, of size and in location indicated for service entrance to building. Sewer piping is specified in a separate section of Division 2.
- H. Install sleeve and mechanical sleeve seal through foundation wall for watertight installation.

3.03 HANGERS AND SUPPORTS

- A. Hanger, supports, and anchors devices are specified in Section 15060. Conform to the table below for maximum spacing of supports:
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs.
- C. Install hangers at the following intervals:

Pipe Materials	Maximum Horizontal Spacing in Feet	Maximum Vertical Spacing in Feet
ABS Pipe	4	4
Cast Iron Pipe	5	15
Copper Tubing - 1-1/4-inch and smaller	6	10
Copper Tubing - 1-1/2-inch and larger	7	10
PVC Pipe	4	4

3.04 INSTALLATION OF PIPING SPECIALTIES

- A. Install backwater valves in sanitary building drain piping as indicated, and as required by the Plumbing Code. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover and of adequate size to remove valve cover for service.
- B. Install expansion joints on vertical risers as indicated and as required by the Plumbing Code.

- C. Install cleanouts in above-ground piping and building drain piping as indicated, and:
 - 1. As required by Plumbing Code;
 - 2. At each change in direction of piping greater than 45 degrees;
 - 3. At minimum intervals of 50 feet for piping 4-inch and smaller and 100 feet for larger piping; and
 - 4. At base of each vertical soil or waste stack.
- D. Install floor and wall cleanout covers for concealed piping, types as indicated.
- E. Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.
- F. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.
- G. Frost-Proof Vent Caps: Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.05 INSTALLATION OF FLOOR DRAINS

- A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Install floor drains at low points of surface areas to be drained or as indicated. Set tops of drains flush with finished floor.
- C. Set drain elevation depressed below finished slab elevation as listed below to provide proper slope to drain:

Depression in Inches	Radius of Area Drained - Feet
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

- D. Trap all drains connected to the sanitary sewer.
- E. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membrane where penetrated.
- F. Position drains so that they are accessible and easy to maintain.

3.06 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the Plumbing Code.
 - 1. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.07 FIELD QUALITY CONTROL

- A. Inspections:
 - 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - 3. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - 4. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the Plumbing Code.
- B. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspection by the plumbing official.
- C. Prepare inspection reports, signed by the plumbing official.
- D. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, according to BOCA Plumbing Code P1702.5.1.
 - 1. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
 - 2. Prepare reports for all tests and required corrective action.

3.08 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as Work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.09 PROTECTION

- A. Protect drains during construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- C. Exposed ABS or PVC Piping: Protect plumbing vents exposed to sunlight with two coats of a water-based latex paint.

END OF SECTION

SECTION 15212 - COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of compressed air systems Work is indicated on Drawings and Schedules and by requirements of this Section. The standard accessories specified in this Section shall be included as a part of each single or duplex air supply system.
- B. Refer to Division 16 Sections for work, which is not Work of this Section.
 - 1. Power supply wiring from power source to power connection on compressed air equipment. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
 - 2. Interlock wiring between electrically operated compressed air equipment units and between compressed air equipment and field-installed control devices.
 - a. Interlock wiring specified as factory-installed is work of this Section.
- C. Provide the following electrical work as Work of this Section, complying with requirements of Division 16.
 - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit manufacturer's technical product data and installation instructions for compressed air systems materials and products.
- B. Test and Inspection Report: Submit a written report to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01400.

1.03 QUALITY ASSURANCE

- B. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install compressed air piping system in accordance with ASME B31.9 "Building Services Piping."
 - 2. CAGI Compliance: Provide compressed air auxiliary piping equipment in accordance with CAGI Standards (Compressed Air and Gas Institute).
 - 3. ASME Compliance: Provide compressed air receivers, and compressed air safety valves in accordance with ASME "Boiler and Pressure Vessel Code"; provide ASME Code Symbol Stamp.
 - 4. UL Compliance: Provide electrical components of compressed air system which have been listed and labeled by UL.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Pressure Regulator and Filter Assemblies:
 - a. Gardner Denver Co., 65NC403QQ.
 - b. Wilkerson, B18-03-000.
 2. Solenoid Valves:
 - a. Asco Red Hat II.
 - b. Double A.
 - c. Skinner.
 3. Particulate Filter:
 - a. Finite Filter, Grade 3PU.
 - b. Pall Trinity Micro, Epocel 3.
 4. Air Regulator Station:
 - a. Curtis.
 - b. DeVilbiss.
 - c. Fisher.
 - d. Jordan.

2.02 MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in compressed air systems. Where more than one type of materials or products are indicated, selection is installer's option.
- B. Compressed Air Distribution: Unless otherwise noted, materials for the compressed air distribution system shall conform to the following specifications. Refer to Section 15105 for piping and Section 15115 for valves listed below:

<u>Item</u>	<u>Spec. No.</u>	<u>Acceptable Alternative Specification</u>
Piping	66.1 with Press Fittings	
Piping - buried	63.1	
Ball Valves	104.8	
Check Valves	110.1	110.6

1. Where piping is exposed in chemical, corrosive, or clean areas, or otherwise so specified on Drawings, materials shall be stainless steel as follows:

<u>Item</u>	<u>Spec. No.</u>
Piping	66.1
Ball Valves	104.8

2. Use 1/4-inch ball valve for gauge cocks.

C. Air Set Assembly: An air set assembly shall be furnished and installed at all locations where high-pressure air connects to equipment, valve and gate operators, instrumentation panels, and where shown on Drawings. The air set assembly shall consist of two, 2-way brass ball valves with 3/8-inch ports, 1/4 turn action and directional handle, and one combination pressure regulator and filter assembly as specified below. Other instrumentation items shall be furnished with their own air set assembly under Division 16 and shall be installed under this Section.

1. Pressure Regulator and Filter Assembly: Regulator assembly shall be the diaphragm-operated type with integral filter, standard mount, 3/8-inch ports and furnished with a 2-inch pressure gauge, T-handle adjustable screw, and self-venting mechanism. Valve and filter body shall be die cast aluminum treated and finished with noncorrosive coating, diaphragm and inner valve shall be Buna-N, spring and adjusting screw shall be cadmium-plated steel. Maximum inlet pressure shall be 150 psi, operating inlet pressure shall be at least 80 psi, and reduced pressure range shall be from 0-125 psi as indicated on Drawings. Diaphragm head shall have a built-in relief valve which will open at a pressure 1 psi over the spring setting. Filter element shall be laminated phenolic resin. An automatic drain shall be provided in the bottom of the accumulator.

2.03 BASIC PIPING SPECIALTIES

A. Provide piping specialties complying with Section 15050, in accordance with the following listing:

1. Pipe escutcheons.
2. Dielectric unions.
3. Pipe sleeves.
4. Sleeve seals.

2.04 BASIC SUPPORTS AND ANCHORS

A. Provide supports and anchors complying with Section 15060.

2.05 PRESSURE GAUGES

A. Provide gauges complying with Section 15125, in accordance with the following listing:

1. Pressure gauges and fittings.

2.06 STANDARD ACCESSORIES

A. Provide the following accessory items for each air supply system: air regulator station, and traps. The size and capacity of each accessory item shall be sufficient to handle the total capacity of the compressor system specified.

B. Quick Disconnect: 200 PSIG working pressure zinc plated steel or brass body and Buna-N seal. Sleeve type, single shut off NPT inlet x 1/4" coupler unless noted otherwise. Provide 3/8" coupler where noted. Coupler design shall be compatible with ARO 210, Industrial Interchange and Tru-Flate plugs. MIL C-4109

- C. Air Regulator Stations: Air regulator station shall consist of a combination pressure-reducing valve and downstream pressure gauge. The capacity of the pressure-reducing valve shall be equal to the output of both compressors and shall be rated for maintaining a downstream pressure of 40 to 80 psi with air upstream pressure as supplied by the specified compressor.
- D. A pressure relief valve shall be provided at the discharge of each compressor as a safety valve. The valve shall be ASME rated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which compressed air systems and equipment is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF COMPRESSED AIR PIPING

- A. Install compressed air piping in accordance with Section 15105.
- B. Install piping with 1/8-inch per foot (1 percent) downward slope in direction of air flow.
- C. Install reducers where required.
- D. Connect branch piping to mains from top of main. Provide drain leg and drain trap at end of each main, each branch, and each low point in piping system.

3.03 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with Section 15105.

3.04 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports and anchors in accordance with Section 15060.
- B. Spacing: Do not exceed 10'-0" spacing between pipe hangers for any size pipe.

3.05 INSTALLATION OF VALVES

- A. Install valves in accordance with Section 15115.

3.06 INSTALLATION OF GAUGES

- A. Install gauges in accordance with Section 15125.

3.07 EQUIPMENT CONNECTIONS

- A. Connect compressed air piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.08 FIELD QUALITY CONTROL

- A. Compressed Air Piping Leak Test: Prior to initial operation of piping system, air purge lines with oil-free dry air, and perform 24-hour standing pressure time-test. Charge line with compressed air to 150 psi; maintain test pressure for 24-hours with pressure loss no greater than 5 psi. During pressure test, test joints and fittings for leaks with soap bubble solution; while bubble testing, hammer joints with rubber or rawhide mallet to break hardened flux.
- B. Repair or replace compressed air piping as required to eliminate leaks, and retest as specified to demonstrate compliance.
- C. Cap (seal) ends of piping where not connected to mechanical equipment.

3.09 ADJUSTING AND CLEANING

- A. Clean, flush, and inspect compressed air systems in accordance with requirements of Section 15105.
- B. Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.

END OF SECTION

SECTION 16050 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER on tracing cloth, Mylar, or sepia paper from which blueprints can be obtained.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 01770. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.

- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 - 1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

2.01 AMMETER

- A. Furnish for OWNER's use an Amprobe, Model ACD-4, digital clamp-on ammeter.

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
 - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).

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- B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group C and Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.
- C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.
- D. Coordinate with telephone company the communication service requirements. Furnish, install, and connect cable and terminal equipment not furnished, installed, or connected by telephone company. Furnish and install a 4-foot by 8-foot by 3/4-inch plywood backboard painted white, raceway from backboard to property line, and cross-connect base and blocks which utilize punchdown wiring methodology.
- E. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- H. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- I. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
- K. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- L. Install access panel or doors where units are concealed behind finished surfaces.
- M. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
 - 1. Exposed Conduit: PVC externally coated rigid metal conduit and fittings.
 - 2. Underground Direct Buried Conduit: PVC externally coated rigid metal conduit.

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3. Underground Concrete Encased Conduit: Fiberglass-reinforced conduit or rigid nonmetallic conduit if the conductors are used for power or 120 VAC; otherwise, use rigid metal conduit.
 4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.
- B. Indoors, use the following wiring materials:
1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - a. Exception: NEMA 7 or 9 areas require explosion-proof flexible conduit.
 2. Exposed Conduit(Nema 12 and Nema 4 areas): PVC externally coated rigid metal conduit or aluminum conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 4X, use rigid Schedule 80 PVC conduit.
 - 2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid metal conduit.
 3. Concealed Conduit: Rigid metal conduit or aluminum conduit unless indicated otherwise.
- C. Minimum size conduit shall be 1 inch unless shown otherwise.
- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.
- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit or fiberglass-reinforced conduit is used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.
- J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets

parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

- K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.
- N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits enter or leave NEMA 4X areas.
 - 3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - 4. Where required by the NEC.
 - 5. Where noted on drawings.

- R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- S. Install device boxes at the height above the floor as follows for:
 - 1. Light switches, 4 feet.
 - 2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 - 3. Thermostats, 4'-0".
 - 4. Clock receptacles, 7'-0".
- T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- U. Position recessed outlet boxes accurately to allow for surface finish thickness.
- V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.

- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.
- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with requirements in Section 01730. In addition, the following requirements apply.
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
 - 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
 - 3. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$$\begin{aligned} R_{\min.} &= 4 (KV + 1) \text{ at } 25 \text{ degrees C winding temp.} \\ R_{\min.} &= IV + 1 \text{ at } 40 \text{ degrees C winding temp.} \end{aligned}$$

- 1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to

- equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
1. Megger bus work phase-to-phase and phase-to-ground. Minimum acceptable steady-state value is 100 megohms.
 2. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).
 3. Test current transformer circuits by applying current to secondary wiring at current transformer terminals until contactor trips.
 4. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
 5. After Work has been completed, demonstrate to OWNER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
 6. Make any specific tests required by the manufacturer's installation instructions.
- D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
1. Vacuum interior of cubicles and remove foreign material.
 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
 4. Fill motor bearings requiring oil.
 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
 6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
 7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
 8. Check exposed bolted power connections for tightness.
 9. Check operation of breakers, contactors, etc., and control and safety interlocks.
 10. Check tightness of bolted structural connections.
 11. Check leveling and alignment of enclosures.
 12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
 13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
 14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 16052- COORDINATION STUDY AND ARC FLASH ANALYSIS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Coordination Study detailing electrical system protection, protective equipment selectivity and arc flash hazard analysis studies shall be performed for this project.
- B. Submit electronic copies of the SKM raw data software files(the files created by the SKM software). The reports shall include the following sections:
 - a. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
 - b. Descriptions, purpose, basis and scope of the study
 - c. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
 - d. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
 - e. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
 - f. Incident energy and flash protection boundary calculations
 - g. Comments and recommendations for system improvements, where needed
 - h. Executive Summary including source of information and assumptions made

1.02 COORDINATION STUDY

- A. Include as part of Contract a complete Coordination and Short Circuit Study from incoming power lines primary switches and transformers through the high voltage switchgear, unit substations, and the motor control centers branch circuits for the new work shown this contract. This includes new medium voltage equipment and circuit breakers installed within existing motor control centers. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Study shall include all coordinating curves with each fuse size, trip settings, and thermal overloads given for connected loads. Curves shall include feeder wire melting curves and transformer ANSI rating points. The study shall also include variable frequency drives harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear. Fuse sizes on motor control centers shall be those shown in Drawings throughout the short circuit and coordination study. Changes in loads from those shown on Drawings shall be incorporated in Study.
- B. Analysis and labeling shall include the existing motor control centers as well as the new motor control centers and medium voltage equipment shown on the contract drawings.

- C. Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- D. Study/report shall be performed by Eaton, General Electric, Rockwell, or Square D. Study results shall be submitted to ENGINEER for approval. Report shall be stamped by a licensed professional electrical engineer in the state of Michigan. Final report shall include the SKM raw data files to be turned over to Owner.
- E. After approval all electrical equipment settings, thermal overloads, and fuses shall be made to conform to approved results. CONTRACTOR shall test all trip settings, time delays, and indicating devices on all switchgear, unit substations, and motor control centers. Tests shall be witnessed by ENGINEER.
- F. Data sheets for test are to be furnished by CONTRACTOR and shall be filled out showing the desired settings from Coordination Study and results obtained from witnessed test. Data sheets shall be signed by those performing test and witness. Test data sheets and motor list showing fuses, thermal overload sizes, etc. shall be submitted to ENGINEER as part of Contract.

PART 2 - PRODUCTS

2.01 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- B. Provide the following information in the study report:
 - 1. Calculation methods and assumptions.
 - 2. Base per unit quantities.
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics.
 - 5. Typical calculations and tabulations of calculated quantities.
 - 6. Results, conclusions, and recommendations.
- C. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low voltage switchgear.
 - 5. Motor control centers.
 - 6. Standby generators and automatic transfer switches.
 - 7. Branch circuit panelboards.
 - 8. Other significant locations throughout the system.

- D. On grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings.
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
 - 3. Adequacy of transformer windings to withstand short-circuit stresses.
 - 4. Cable and busway sizes for ability to withstand short-circuit heating.
 - 5. Notify Owner in writing, of existing circuit protective devices improperly rated for the calculated available fault current.

2.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 - 1. Electric utility's protective device
 - 2. Medium voltage equipment relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.03 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all medium voltage and 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.04 REPORT SECTIONS

- A. Input Data:
 - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 - 2. Short-circuit reactance of rotating machines with associated X/R ratios
 - 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 - 4. Bus duct type, size, length, and impedance
 - 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 - 6. Reactor inductance and continuous ampere rating
 - 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 - 1. Source fault impedance and generator contributions
 - 2. X to R ratios
 - 3. Asymmetry factors
 - 4. Motor contributions
 - 5. Short circuit kVA
 - 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
 - 1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.

- c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
- 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations.
 - 1. Arcing fault magnitude
 - 2. Device clearing time
 - 3. Duration of arc
 - 4. Arc flash boundary
 - 5. Working distance
 - 6. Incident energy
 - 7. Hazard Risk Category
 - 8. Recommendations for arc flash energy reduction

PART 3 – EXECUTION

3.01 ARC FLASH WARNING LABELS

- A. The CONTRACTOR shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date
- C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided.
 - 2. For each motor control center, two arc flash labels shall be provided, one at each end of the motor control center.
 - 3. For each low voltage switchboard, one arc flash label shall be provided
 - 4. For each switchgear or unit substations, two arc flash labels shall be provided, one at each end of the equipment or near each main breaker.
 - 5. For each medium voltage switch, one arc flash label shall be provided.

- D. Labels shall be field installed by the electrical supplier performing the studies, local power company, or engineering service division of the equipment manufacturer during the Startup and Acceptance Testing.

3.02 ARC FLASH TRAINING

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 16 hours, two trips to the Owners facility). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET). Assume for twenty (20) individuals of the Owners staff to be trained.

END OF SECTION

SECTION 16060 - GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.
- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Metal building frames.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
 - 12. Lighting standards.
 - 13. Landscape lighting.
 - 14. Signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
 - 2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:

1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Ground Bus: 0.25 inch by 1 inch minimum copper ground bus where indicated.
4. Service Arrester: Electrical service arrester, 480 volts, 3-phase, 4-wire, for exterior mounting.
5. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 20 feet.
6. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.
- B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
- C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- D. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.
- H. Bond bare No. 4/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.

- I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 4/0 AWG grounding cable carried in duct bank.
- J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

3.02 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester using the 3-point fall of potential method. Testing shall be performed during normal dry weather conditions with at least 5 non-rain days elapsing prior to test. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less by driving additional ground rods; then retest to demonstrate compliance.
- B. Test ground paths for continuity by applying a low DC voltage source of current, capable of furnishing up to 100 amps, between electrical equipment grounds and ground grid. Grounding path must conduct a 100-amp current at a resistance of 0.010 ohms or less as calculated from circuit voltage.

END OF SECTION

SECTION 16070 - SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products.
 - 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Racor, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

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SRF No. 5696-01

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2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be stainless steel. Products for use outdoors, in NEMA 4 areas, or embedded in concrete or in Nema 12 areas indoors shall be stainless steel.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and stainless steel spring clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: 316 stainless steel wedge or sleeve type.
 - 2. Toggle Bolts: 316 stainless steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, 316 stainless steel.
- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of 304 stainless steel.
- E. U-Channel Systems: 12 gauge or 0.105-inch-thick 316 stainless steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel 316 stainless steel components.
- B. 316 stainless steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Steel Pipe: Fabricate from Schedule 40 stainless steel pipe.
 - 2. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labeling for cables and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- C. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.
- E. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- F. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

- G. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- H. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- I. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- J. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct buried and in raceway.
- D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

<u>Phase</u>	<u>480/277 Volts</u>
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

- E. Wiring Standards:
 - 1. 480/277 Volt, 3-Phase Power:
 - a. Brown.
 - b. Orange.
 - c. Yellow.
 - d. Grey Neutral.

2. 208 Volt, 3-Phase Power:
 - a. Black.
 - b. Red.
 - c. Blue.
 3. 240/120 Volt, 1-Phase Power:
 - a. Black.
 - b. Red.
 - c. White Neutral.
 4. Motor Leads, Control Cabinet/MCC:
 - a. Black, numbered L1-T1, etc.
 5. Control Wiring:
 - a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
 - b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
 - c. Blue DC.
 - d. Green Ground.
- F. Use conductors with color factory applied entire length of conductors except as follows:
1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- G. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- H. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 16090 - DEMOLITION AND EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Limited scope general construction materials and methods for application with electrical installations as follows:
 - 1. Selective Demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling electrical materials and equipment made obsolete by these installations.
 - 2. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.

1.02 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following Project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following Project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. OWNER will not be responsible for interpretations or conclusions drawn from this information.
 - 4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
 - 5. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to ENGINEER prior to utility interruption.
 - 6. Use of explosives is not permitted.

1.03 SEQUENCING AND SCHEDULING

- A. Coordinate the shutoff and disconnection of electrical service with OWNER and utility company.
- B. Notify ENGINEER at least 5 days prior to commencing demolition operations.

- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 SELECTIVE DEMOLITION

- A. Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to location designated for storage.
- C. Disposal and Clean Up: Remove from Site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceway systems, controls, and fixtures.
 - 2. Raceways embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings.
- E. Perform cutting and patching required for demolition in accordance with Section 01730.

3.02 EXCAVATION

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- C. Remove and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- D. Install sediment and erosion control measures in accordance with local codes and ordinances.
- E. Dewatering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- F. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
1. Locate and retail soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- G. Excavation for Underground Vaults and Electrical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. Excavate, by hand, areas within drip line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- H. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to uniform width, sufficiently wide to provide ample working room and minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 2. Excavate trenches to depth indicated or required.
 3. Limit length of open trench to that in which installations can be made and trench backfilled within same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
- I. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (1 degree C).
- J. Backfilling and Filling. Place soil materials in layers to required subgrade elevations for each area classification listed below:
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation of raceways, provide a 4-inch-thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas, use excavated or borrowed materials.
- K. Backfill excavations as promptly as work permits, but not until completion of following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.

- L. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- M. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- N. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- O. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact to 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during or subsequent to compaction operations.
- P. Subsidence. Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

END OF SECTION

SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Medium-Voltage Cable.
 - 3. Instrument Cable.
 - 4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 01600.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. NEMA/ICEA Compliance: Provide components which comply with following standards:
 - 1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
 - 2. NEMA WC 71-1999/ICEA S-96-659-1999, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for use in the Distribution of Electrical Energy.
 - 3. NEMA WC 74-2000/ICEA S-93-639, 5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy.
- C. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- D. Network Wiring Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

- F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Medium-Voltage Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. Kerite Co.
 - d. The Okonite Co.
 - e. Prysmian Cables & Systems.
 - f. Southwire Co.
 - 4. Medium-Voltage Cable Splicing and Terminating Products and Accessories:
 - a. Adelet-PLM.
 - b. Amerace Corp.
 - c. Electrical Products Division 3M.
 - d. G&W Electric Co.
 - e. M.P. Husky Corp.
 - f. Raychem Corp.
 - g. RTE Components.
 - 5. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 6. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.
- B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.
- C. Insulation: Provide RHW/USE insulation for power conductors used in single- and 3-phase circuits with more than 120 volts to ground. Provide RHW/USE, XHHW, or THWN/THHN insulation for power conductors used in single- and 3-phase circuits with 120 volts or less to ground
 - 1. Provide RHW, THHN/THWN, or XHHW insulation for grounding conductors installed in raceways.
 - 2. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 MEDIUM-VOLTAGE CABLE

- A. Cable shall be single-conductor type, size as indicated, and conforming to UL Standard 1072, "Medium Voltage Power Cables."
- B. Cable shall be ethylene propylene rubber (EPR) insulated and shall conform to NEMA Standard WC 74-2000 (ICEA S-93-639) "5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy."
- C. Conductors: Class B stranded, annealed copper.
- D. Conductor Shield: Extruded, semiconducting.
- E. Insulation Shield: Extruded, semiconducting.
- F. Concentric Neutral: Evenly spaced, annealed, coated, solid copper wires applied concentrically over semiconducting insulation shield. Individual wires shall be No. 14 AWG minimum. Concentric neutral ampacity shall be not less than 1/3 the ampacity of central conductor.
- G. Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulation shield or evenly spaced solid copper wires applied concentrically over semiconducting insulation shield.
- H. Cable Jacket: Sunlight-resistant PVC, cross-linked polyolefin, or chlorosulfonated polyethylene (hypalon).
- I. Cable Voltage Rating: 5 kV phase to phase.
- J. Cable Voltage Rating: 8 kV phase to phase.

- K. Cable Voltage Rating: 15 kV phase to phase.
- L. Cable Voltage Rating: 25 kV phase to phase.
- M. Cable Voltage Rating: 28 kV phase to phase.
- N. Cable Voltage Rating: 35 kV phase to phase.
- O. Cable Voltage Rating: 46 kV phase to phase.

2.05 MEDIUM-VOLTAGE SPLICING AND TERMINATING PRODUCTS

- A. Types: Compatible with cable materials and shall be suitable for indoor or outdoor environments as required.
- B. Connectors: Compression type as recommended by cable or splicing kit manufacturer for application.
- C. Splicing and Terminating Kits: As recommended by manufacturer in writing for specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain components required for a complete splice or termination including detailed instructions and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of cable it connects and maintain current carrying capacity and mechanical strength of cable.

2.06 INSTRUMENT CABLE

- A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 16 or No. 18AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding.

2.07 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.
 - 3. Provide plenum rated cable where installed exposed.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to ENGINEER. Test reports

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shall include ambient temperature and humidity at time of testing. Notify ENGINEER 48 hours prior to test with schedule.

- B. Medium-Voltage Cable Tests shall include high-potential test of cable and accessories and such tests and examinations required to achieve specified objectives. Where new cables are spliced to existing cables, high-potential test shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, an insulation resistance test and continuity test on the length of cable including the splice with existing cables being tested to the nearest disconnect point.
- C. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by CONTRACTOR with at least 5 years of experience in testing Network cabling systems.
 - 1. TESTING: CONTRACTOR shall test each network cable segment. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER.
 - 2. DOCUMENTATION (Network Cable): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 - c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 - 3. ACCEPTANCE: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and receipt of documentation.
- D. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to ENGINEER.

END OF SECTION

SECTION 16130 - RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
1. Flexible metal conduit.
 2. Liquidtight flexible conduit.
 3. Underground plastic utilities duct.
 4. Rigid metal conduit.
 5. Rigid nonmetallic conduit.
 6. Surface raceways.
 7. PVC externally coated rigid metal conduit.
 8. Fiberglass reinforced conduit.
 9. Aluminum conduit.
 10. Wireway.
 11. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for the following products:
 - a. Surface raceway and fittings.
 - b. Wireway and fittings.
 - c. Conduit.
 - d. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:
1. Conduit:
 - a. Allied Tube.
 - b. Carlon.

- c. Johns Manville.
- d. Occidental Coatings.
- e. Orangeburg.
- f. Perma-Cote Industries.
- g. Republic Steel.
- h. Robroy Industries.
- i. Steelduct Co.
- j. Triangle Conduit.
- k. Wheatland Tube.
- l. Youngstown Sheet and Tube.
- 2. Liquidtight Conduit:
 - a. Anamet, Inc.
 - b. Carlon.
 - c. Electric-Flex.
 - d. Thomas and Betts.
- 3. Conduit Bodies:
 - a. Adalet-PLM.
 - b. American Electric.
 - c. Appleton Electric Co.
 - d. Carlon.
 - e. Crouse-Hinds Division, Cooper Industries, Inc.
 - f. Delta Industrial Products.
 - g. Killark Electric Mfg. Co.
 - h. Kraloy Products Co.
 - i. O-Z/Gedney Co.
 - j. Perma-Cote Industries.
 - k. Robroy Industries.
 - l. Spring City Electrical Mfg. Co.
- 4. Conduit Thread Paint:
 - a. CRC Chemicals, USA.
 - b. Sherwin Williams.
 - c. ZRC Chemical Products Co.
- 5. Wireway:
 - a. Alrey-Thompson Co.
 - b. Anchor Electric Co.
 - c. Hoffman Engineering Co.
 - d. Keystone/Rees, Inc.
 - e. Robroy Industries, Inc.
 - f. Square D Company.
- 6. Surface Metal Raceway:
 - a. Allied Tube & Conduit.
 - b. B-Line Systems, Inc.
 - c. Butler Mfg. Co.
 - d. Hoffman Engineering Co.
 - e. Isoduct Energy Systems.
 - f. Isotrol Systems.
 - g. Keystone/Rees, Inc.
 - h. Square D Company.
 - i. The Wiremold Co.

7. Surface Nonmetallic Raceway:
 - a. Anixter Brothers, Inc.
 - b. Hoffman Engineering Co.
 - c. Hubbell, Inc.
 - d. Panduit Corp.
 - e. Premier Telecom Products, Inc.
 - f. Thermotools Co.
 - g. The Wiremold Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.
- B. PVC Externally Coated Rigid Metal Conduit and Fittings: ANSI C 80.1 and NEMA RN 1., Type 40, 40 mil nominal coating and thickness. The bond of the PVC to the substrate shall be stronger than the tensile strength of the PVC.
- C. Flexible Metal Conduit: UL 1, zinc-coated metal.
- D. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.
- E. Rigid metal aluminum conduit: ANSI C 80.5, 6063 alloy in temper designation T-1.

2.03 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. Underground PVC and ABS Plastic Utilities Duct: NEMA TC 6, Type I for encased burial in concrete, Type II for direct burial.
- D. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC 9; match to duct type and material.
- E. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.
- F. Fiberglass-Reinforced Conduit and Fittings: CSA B196.1 and B1089 A.

2.04 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
 1. Rigid Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.

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2. Intermediate Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
3. Electrical Metallic Tubing: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and compression type or setscrew connectors.
4. PVC Externally Coated Rigid Metal Conduit: Use hot-dipped galvanized or cadmium-plated cast or malleable iron conduit bodies with threaded hubs factory PVC-coated. Field application of PVC coating to conduit bodies is not acceptable. Secure covers using PVC encapsulated or stainless steel screws.
5. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.
6. NEMA 7 and NEMA 9 Areas: Use materials conforming to UL standards for the area.

2.05 WIREWAYS

- A. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.
- B. Wireway covers shall be hinged type.

2.06 SURFACE RACEWAYS

- A. Sizes and channels as indicated. Provide fittings that match and mate with raceway.
- B. Surface Metal Raceway: Construct of galvanized steel with snap-on covers, with 1/8-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required.
- C. Surface Nonmetallic Raceway: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color. Raceway and system components shall meet UL 94 requirements for nonflammable, self-extinguishing characteristics.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16135 - CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
 - 1. Outlet and device boxes.
 - 2. Pull and junction boxes.
 - 3. Terminal boxes.
 - 4. Bushings.
 - 5. Locknuts.
 - 6. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 - 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 - 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.

- h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co.
- 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type JB, GS, or SHE.
 - b. Crouse-Hinds, Type GS or GRF.
- 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co.
- 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.
 - f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
- 6. Junction and Pull Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 7. Terminal Boxes:
 - a. AMFCO.
 - b. Boss.
 - c. Hoffman.
 - d. Keystone.
 - e. Hope.
- 8. Bushings, Knockout Closures, Locknuts, and Connectors:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midland-Ross Corp.
 - g. Midwest Electric, Cooper Industries, Inc.
 - h. OZ/Gedney Co., General Signal Co.
 - i. RACO Div., Harvey Hubbell, Inc.
 - j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

- A. Outlet Boxes: Suitable for the conduit system installation as follows:
 - 1. Exposed Conduit: Provide cast outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 12 and 4 areas and undesignated areas.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel boxes where PVC-coated conduit is specified.
 - 2. Concealed Conduit: Provide 316 stainless steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.
- B. Device Boxes: Suitable for the conduit system as follows:
 - 1. Exposed Conduit: Provide 316 stainless device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel device boxes where PVC-coated conduit is specified.
 - 2. Concealed Conduit: Provide 316 stainless steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.
- C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:
 - 1. Exposed Conduit: For pull and junction boxes provide 316 stainless steel hinged boxes. Provide exterior mounting lugs. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide nonmetallic pull and junction boxes in NEMA 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel boxes for areas where PVC conduit is used.
 - 2. Concealed Conduit: Provide 316 stainless steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.
- D. Terminal Boxes: Provide compression lug type terminal strips in each terminal box with a minimum of 20 percent spare terminals. Provide appropriate NEMA enclosure rating for area in which terminal box is installed. Boxes to be 316 stainless steel.
- E. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at 316 stainless steel enclosures in NEMA 12 and Nema 4 areas.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16139 - VAULTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of underground concrete encased conduit (ductbank) vault, manhole, and handhole work as indicated by Drawings, and is hereby defined to include those units which are utilized exclusively for installation of instrumentation, communication, and control media and equipment; and electrical power cables, wires, and equipment.
- B. Types of vaults, manholes, and handholes in this Section include, but are not limited to:
 - 1. Utility vaults.
 - 2. Electrical manholes.
 - 3. Electrical handholes.
 - 4. Concrete encased conduit (ductbank).
- C. Related Work in Other Sections:
 - 1. Excavation and backfill required in connection with vaults, manholes, and handholes.
 - 2. Concrete Work required in connection with vaults, manholes, and handholes.
 - 3. Waterproofing and dampproofing of vaults, manholes, and handholes.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's Data: Submit manufacturer's data on concrete encased conduit vault, manhole, and handhole components and associated specialty products.
 - 2. Submit Shop Drawings for vault system, showing raceway types and sizes, locations, and elevations for horizontal runs. Include details of underground structures, accessories, fittings, and connections.

1.03 QUALITY ASSURANCE

- A. Prefabricators: Firms regularly engaged in manufacture of factory fabricated vaults, manholes, and handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:
 - 1. ANSI Compliance: Comply with requirements of ANSI C2, "National Electrical Safety Code," pertaining to construction and installation of concrete encased conduit vaults, manholes, and handholes.
 - 2. ASTM Compliance: Comply with applicable requirements of American Society for Testing and Materials (ASTM) standards pertaining to construction and materials for vaults, manholes, and handholes.
 - 3. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors." Provide vault, manhole, and handhole accessories which are UL listed and labeled.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
- B. Prefabricated Units:
 - 1. Advance Concrete.
- C. Manhole Frames and Covers:
 - 1. James B. Clow & Sons.
 - 2. Neenah Foundry Co.

2.02 MATERIALS FOR FIELD FABRICATED UNITS

- A. Concrete Materials: Comply with Division 3 requirements for applicable product requirements of concrete materials, except as otherwise indicated.
- B. Concrete Masonry Units: ASTM C 139.
- C. Masonry Mortar: ASTM C 270, Type M:
 - 1. For minor amounts of mortar comprising less than 2.0-cubic-foot packaged mortar materials complying with ASTM C 387, Type M, may be substituted at CONTRACTOR's option.
- D. Manhole Frames and Covers: Grey cast iron, ASTM A 48, Class 30B:
 - 1. Dip coat frames and covers in black asphalt paint. Provide 30-inch-diameter openings for vaults and manholes carrying low-voltage circuits. Provide 36-inch-diameter openings for vaults and manholes carrying medium-voltage circuits.
 - 2. Furnish covers with cast-in legend "ELECTRIC" on roadway face.
- E. Vault and Manhole Steps: Grey cast iron, ASTM A 48, Class 30B, integrally cast into vault and manhole sidewalls, unless otherwise indicated.

2.03 FACTORY FABRICATED VAULTS, MANHOLES, AND HANDHOLES

- A. Concrete Vaults and Manholes: Provide watertight, precast concrete vaults and manholes in types and sizes indicated, with access knockout entrance holes for raceways and cable, cast-iron manhole access cover and frame with machined bearing surfaces, with pulling/lift irons, sump/drainage box and vertical embedded continuous slot inserts.
- B. Manhole Frames and Covers: Grey cast iron, ASTM A 48, Class 30B:
 - 1. Dip coat frames and covers in black asphalt paint. Provide 30-inch-diameter openings for vaults and manholes carrying low-voltage circuits. Provide 36-inch diameter openings for vaults and manholes carrying medium-voltage circuits.
 - 2. Furnish covers with cast-in legend "ELECTRIC" on roadway face.

3. Provide reinforced concrete for vaults and manholes with slabs designed for H-20 highway loading and walls designed for a lateral earth pressure of 80 pounds per square foot per foot of depth.
- C. Handholes and Boxes: Provide handholes and boxes for pulling, splicing, and terminating conductors, in types and sizes indicated, with watertight cover and penta-head bolts and knockout access holes; equip base with sump/drainage box.
 1. Provide concrete body with cast iron cover and ring.
- D. Accessories: Provide vault, manhole, and handhole accessories, including pulling-in irons, embedded cable support accessories, cable rack arms, porcelain saddles, sump pump pits, ladders, mastics, and sealants as indicated or required.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which concrete encased conduit vaults, manholes, and handholes are to be installed, and notify CONTRACTOR in writing of those conditions detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 UNDERGROUND CONCRETE ENCASED CONDUIT

- A. Support conduit to be encased on approved spacers at the dimensions shown on Drawings.
- B. Reinforce concrete encasement as indicated.
- C. Slope duct runs a minimum of 0.5 percent in the direction indicated.
- D. Maintain a 12-inch minimum clearance between concrete encasement and yard piping.
- E. Provide 24-inch minimum clearance from top of concrete encasement to finished grade unless otherwise noted.
- F. Mandrel and clean all underground conduits prior to cable installation.

3.03 INSTALLATION OF VAULTS, MANHOLES, AND HANDHOLES

- A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements.
- B. Set manhole frames and covers flush with sidewalk, pavement, or ground surface. In gravel driveways set covers 4 inches below surface.
- C. Coordinate with other Work, including electrical raceway and wiring Work, as necessary to interface installation of vaults, manholes, and handholes with other Work.

3.04 INSTALLATION OF FIELD FABRICATED UNITS

- A. Fabricate vaults, manholes, and handholes, of types and sizes indicated, watertight, and equip with manhole metal access cover, steps, access holes for raceways and cables, sump/drainage box, and bolting inserts.
- B. Masonry Construction Manholes:
 - 1. Use concrete masonry units to construct masonry manholes and vaults.
 - 2. Construct manholes and vaults in sizes and shapes indicated.
 - 3. Mix mortar with only enough water for workability. Retempering of mortar is not permitted. Keep mortar mixing and conveying equipment clean. Do not deposit mortar upon, or permit contact with, the ground.
 - 4. Lay masonry in mortar to form full-bed joints, with end and side joints formed in one operation, and with bed and vertical joints not more than 5/8-inch wide. Protect fresh masonry from freezing and also from too rapidly freezing and from too rapidly drying.
 - 5. Apply a 1/2-inch-thick mortar coating on both interior and exterior wall surfaces.
 - 6. Where manholes are installed in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3 inches above finish surface unless otherwise indicated.
 - 7. Use an epoxy bonding compound where manhole steps are mortared into masonry walls.
- C. Cast-In-Place Concrete Manholes:
 - 1. Use cast-in-place concrete to construct manholes and vaults.
 - 2. Construct manholes and vaults of sizes and shapes indicated.
 - 3. Dampproofing and Waterproofing:
 - a. Coordinate dampproofing and waterproofing Work with installation of field fabricated units as necessary for proper interface.
 - b. Install dampproofing and waterproofing materials as indicated.

3.05 INSTALLATION OF FACTORY FABRICATED UNITS

- A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements and serve intended purposes.
- B. Precast Concrete Units: Place precast concrete sections as indicated. Where units occur in pavements, set tops of frames and covers flush with finish surface, unless otherwise indicated. Use epoxy bonding compound where steps are mortared into unit walls.
 - 1. Install rubber joint gasket, complying with ASTM C 443, at joints between sections.
 - 2. Apply bituminous mastic coating at joints between sections.
 - 3. Coordinate dampproofing and waterproofing Work with installation of precast concrete units as necessary for proper interface.
 - 4. Install dampproofing and waterproofing materials as indicated.

3.06 BACKFILLING

- A. Delay backfilling of excavations surrounding vaults, manholes, and handholes until after initial inspection has been completed.

3.07 GROUNDING AND BONDING

- A. Provide equipment grounding and bonding connections for exposed metal parts in vaults, manholes, and handholes as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Receptacles.
 - 2. Ground fault circuit interrupter receptacles.
 - 3. Plugs.
 - 4. Plug connectors.
 - 5. Telephone and network outlets.
 - 6. Wall plates.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Bryant Electric Co., Division of Hubbell Corporation.
 - 2. Cooper Wiring Devices.
 - 3. Hubbell, Inc.
 - 4. Leviton Manufacturing Co., Inc.
 - 5. Pass and Seymour, Inc.

2.02 WIRING DEVICES

- A. Provide devices which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Provide ivory color devices and wall plates except as otherwise indicated.
- B. Receptacles: Provide specification grade or heavy-duty grounding receptacles with the NEMA rating shown on Wiring Device Schedule on Drawings. Comply with UL 498 and NEMA WD1.
- C. Receptacles, Industrial Heavy-Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

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- D. Ground Fault Interrupter (GFI) Receptacles: Provide specification grade or heavy-duty "feed-through" type ground fault circuit interrupter, with integral grounding type NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide units rated Class A, Group 1, per UL Standard 94.3.
- E. Plugs: 15 amperes, 125 volts, 3-wire, grounding, armored cap plugs, parallel blades with cord clamp, and 0.4-inch cord hole; match NEMA configuration with power source's.
- F. Plug Connectors: 15 amperes, 125 volts, bakelite-body armored connectors, 3-wire, grounding, parallel blades, double wipe contact, with cord clamp, and 0.4-inch cord hole, match NEMA configuration to mating plug's. Arrange as indicated.
- G. Telephone and Network Outlets: Telephone outlets shall consist of box, wall plate, and RJ-12 jack. Network outlets shall consist of box, wall plate, and RJ-45 jack. Network outlet shall comply with requirements of CAT-5E cabling systems. Wall plates shall match color and style of receptacle and switch wall plates used throughout the Project.

2.03 WIRING DEVICE ACCESSORIES

- A. Wall plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Exterior receptacle covers shall provide rainproof protection while in use. Conform to requirements of Section 16075. Provide plates possessing the following additional construction features:
 - 1. NEMA 12 and Unclassified Areas. Material and Finish: 0.04-inch-thick stainless steel, or 0.04-inch-thick brass, chrome plated.
 - 2. NEMA 4 Area Material and Finish: Cast screw cap and cover plate for receptacles. Cast cover plate with lever or plunger operator for switches.
 - 3. NEMA 4X Material and Finish: Non-metallic, watertight wall plates 0.05-inch-thick aluminum, anodized.
 - 4. NEMA 7 and NEMA 9 Material and Finish: cast metal cover plates meeting NEC requirements for area.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16220 - MOTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section applies, in general, to all electric or DC motor-driven equipment provided under Divisions 2 through 16 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
 - 2. Submit product literature for each motor.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:
 - 1. Motors:
 - a. Marathon Blue Chip Series.
 - b. Siemens, Inc.
 - c. General Electric Co.
 - d. Reliance Electric Co.
 - e. U.S. Electric Motors.
- B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

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2.02 MATERIALS

- A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.
- B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

- A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1-1993, Rev. 1, Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
 - 1. The motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.0 or 1.15 service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
 - 2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
 - 3. The motors shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seconds.
- B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).
- C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.
- D. Multispeed motors are to be supplied with separate windings for each speed. The cost to change starters for motors supplied with reconnectable windings will be the responsibility of equipment (motor) supplier and must be coordinated with ENGINEER.
- E. All explosion-proof motors shall meet NEC Class 1, Division I, Group D, requirements with T2A temperature rating.
- F. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:
 - 1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.

2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be suitable for use on 208 volt power systems under their given load conditions. They shall have bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
 3. From 2 to 200 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard open drip-proof specifications as a vertical motor when called for or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s).
- G. Horizontal and vertical motors may also be weather protected, Type I, and shall have encapsulated or sealed windings.
- H. Open drip-proof type motors shall have encapsulated or sealed windings when called for on Drawings or Equipment Schedules.
- I. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.
- J. Motors above 200 Horsepower: Motors shall be of special design as detailed in specific sections of the Specifications. All special purpose motors, such as wound-rotor, multi-speed, variable speed, etc., shall be as detailed in specific Sections of the Specifications. Motor shall be furnished with ten (10) 100-ohm (or as required to be accepted as inputs to the motor protective device) platinum RTD Type temperature sensors for the stator windings; 2 sensors per phase per winding; and 2 temperature sensors for motor bearings; 1 sensor per bearing and 1 for motor ambient temperature. RTD sensors shall be the 3-wire type and shall be wired to a terminal strip in a common frame mounted terminal box.
- K. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:
1. TE Totally Enclosed, may be nonventilated, fan-cooled or air-over type.
 2. TENV Totally Enclosed Nonventilated.
 3. TEFC Totally Enclosed Fan-cooled.
 4. TEEP Totally Enclosed Explosion-proof, Class I, Div. I, Group D.
 5. ODP Open Drip-proof.
 6. WPI Weather Protected Type I.
 7. E/S Encapsulated or Sealed Windings.
 - a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.
- L. See NEMA Standard MG1 for definition of above terms.
- M. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average

expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

2.04 FABRICATION

- A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's written installation and alignment instructions.
- B. Lubricate oil-lubricated bearings.
- C. Provide electrical wiring and connections as specified in Division 16 Sections.

3.02 FIELD QUALITY CONTROL

- A. Inspect all terminations for proper connection.
- B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

- A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600 certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by any connection or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER; and
 - 5. That OWNER's representative has been instructed in the proper maintenance and operation of the equipment.
 - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

HIGH EFFICIENCY MOTOR SCHEDULE NO. 16220.2
MOTOR OPERATING CHARACTERISTICS

HP	RPM Syn.	Efficiency (percent)						
		Guar. Min.	Nominal			Power Factor (percent)		
		Full	1/2	3/4	Full	1/2	3/4	Full
1	1800	81.5	78.1	81.0	81.5	54.2	67.3	75.8
	1200	75.5	69.5	75.6	78.5	38.4	49.4	58.3
1.5	3600	78.5	78.4	80.2	81.5	75.3	84.4	88.8
	1800	81.5	79.2	82.9	84.0	52.1	65.1	74.0
	1200	81.5	80.5	83.4	84.0	44.0	56.6	85.6
2	3600	81.5	78.8	82.9	84.0	66.3	78.4	85.0
	1800	81.5	78.8	82.6	84.0	48.9	61.7	70.0
	1200	84.0	83.0	83.6	86.5	46.6	59.6	68.0
3	3600	84.0	75.4	84.3	86.5	69.7	80.0	85.6
	1800	86.5	86.9	88.5	88.5	62.3	73.9	79.9
	1200	86.5	84.5	87.5	88.5	45.9	58.3	68.0
5	3600	86.5	86.2	88.2	88.5	71.7	81.7	86.4
	1800	88.5	84.0	88.2	88.5	68.5	79.2	84.6
	1200	86.5	85.8	88.2	88.5	50.8	63.8	71.9
7.5	3600	86.5	82.9	86.7	88.5	75.9	84.3	88.1
	1800	88.5	89.2	90.3	90.2	66.5	77.2	82.4
	1200	86.5	87.5	88.8	88.5	58.6	68.8	73.7
10	3600	86.5	87.7	89.0	88.5	77.1	84.5	87.6
	1800	88.5	89.3	90.4	90.2	67.6	77.4	81.9
	1200	88.5	89.0	90.3	90.2	60.1	70.2	74.9
15	3600	88.5	82.3	87.4	90.2	81.1	87.2	90.4
	1800	90.2	91.0	91.9	91.7	68.5	78.1	82.3
	1200	88.5	89.9	90.6	90.2	67.4	77.1	81.4
20	3600	90.2	89.1	91.1	91.7	83.7	88.5	90.5
	1800	90.2	90.9	91.9	91.7	68.9	78.1	81.8
	1200	90.2	91.0	91.0	91.7	69.8	78.5	81.9
25	3600	90.2	91.6	92.0	91.7	81.9	88.6	90.6
	1800	91.7	92.8	93.2	92.4	72.7	81.4	84.5
	1200	90.2	90.0	91.4	91.7	79.8	84.5	85.5
30	3600	90.2	90.6	91.7	91.7	81.1	87.8	90.3
	1800	91.7	92.8	93.3	93.0	71.5	80.6	84.2
	1200	90.2	91.7	92.0	91.7	78.9	85.4	86.8
40	3600	90.2	89.1	91.2	91.7	83.8	88.6	89.9
	1800	91.7	91.0	92.6	93.0	71.6	80.6	84.2
	1200	91.7	93.0	93.3	93.0	80.9	86.4	88.0
50	3600	90.2	88.7	90.8	91.7	82.5	90.8	92.0
	1800	93.0	92.4	93.7	94.1	76.4	83.7	86.3
	1200	91.7	93.0	93.3	93.0	80.9	87.3	88.9
60	3600	91.7	89.9	92.0	93.0	84.9	89.9	91.6
	1800	93.0	93.2	94.0	94.1	76.3	84.0	86.8
	1200	91.7	92.5	93.1	93.0	75.8	82.9	85.5
75	3600	93.0	91.0	93.1	94.1	82.6	88.7	90.9
	1800	93.0	92.6	93.8	94.1	76.4	83.8	86.6
	1200	93.0	93.5	94.2	94.1	75.1	82.4	84.7
100	3600	93.0	91.3	93.3	94.1	86.1	89.7	91.0
	1800	94.1	93.8	94.8	95.0	83.8	87.6	89.0
	1200	93.0	93.1	93.9	94.1	72.5	80.0	83.2
125	3600	93.0	91.2	93.1	94.1	83.0	88.3	89.0
	1800	93.7	93.5	94.6	95.0	79.2	84.6	86.0
	1200	93.0	93.5	94.2	94.1	75.2	82.3	85.2
150	3600	93.0	91.8	93.4	94.1	85.3	89.3	89.1
	1800	94.1	93.7	94.7	95.0	81.6	86.4	86.6
	1200	94.1	94.1	94.9	95.0	77.2	84.4	85.7
200	3600	94.1	92.7	94.3	95.0	83.3	87.5	88.5
	1800	94.5	94.2	94.9	95.0	80.0	85.6	86.7
	1200	94.3	94.2	94.9	95.0	78.0	84.5	86.0
250	3600	94.3	94.8	95.5	95.3	83.0	87.5	88.5
	1800	94.3	96.0	96.0	95.8	79.5	85.6	83.0

END OF SECTION

SECTION 16270 - TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of transformers specified, and include the following:
1. Dry-type transformers (lighting transformers).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
 2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
 3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
 2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Acme Electric Corporation.
 2. Cutler-Hammer.
 3. General Electric Company.
 4. Hevi-Duty Electric Div., General Signal Corp.
 5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

- B. Dry-Type Distribution Transformers (45 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated, single phase, 60 hertz, 10 kV BIL, 4.0 percent impedance, with 480 volts primary and 240/120 volts secondary; or K-rated 13 three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220 degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.
- C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16330 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Distribution and power transformers with medium-voltage primaries. Types of transformers specified in this Section include:
 - 1. Dry type secondary substation.
 - 2. Pad-mounted type.
 - 3. Liquid filled secondary substation type.
 - 4. Pole-mounted transformers.
 - 5. Cast coil dry type.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings for each transformer, including dimensional plans, sections, and elevations showing minimum clearances, installed devices, and materials lists.
 - 2. Product data for each product specified.
 - 3. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.
- B. Product Test Reports: Certified copies of manufacturer's design and factory tests as follows.
 - 1. Turns ratio.
 - 2. Polarity.
 - 3. Resistance.
 - 4. Impedance.
 - 5. Load losses.
 - 6. No load losses.
 - 7. Exciting current.
 - 8. Regulation at 80percent power factor.
 - 9. Impulse test (transformers larger than 750 kVA only).
 - 10. Corona test (transformers larger than 1500 kVA only).
- C. Power company approval for all transformers interfacing with power company connections. Submit one copy of product data signed by power company.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. ASEA Brown Boveri.
 - 2. Cooper Power Systems.

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3. Hevi-Duty Electric.
4. ABB National.
5. Niagara Transformer Corp.
6. Square D Co.

2.02 TRANSFORMERS, GENERAL

- A. Medium-Voltage Transformers: Factory assembled and tested, general-purpose, air-cooled, dry type or liquid filled as indicated, and having characteristics and capacities as indicated.
- B. Windings: 2-winding type, designed for operation with high-voltage windings connected to the system, indicated on Drawings. Provide 4- or 5-legged cores for all wye-wye connected transformers.
- C. Finishes: Thoroughly clean interior and exterior prior to coating enclosure and equipment, including bolted joints, with rust inhibiting primer coat. Provide 2 finish coats of manufacturer's standard color finish.
- D. Forced Air-Cooled Transformers shall comply with the following requirements:
 1. Forced air cooling equipment shall consist of cooling fans, temperature sensing devices, and controls complete with housing, mounting devices, conduit, and wiring. Operation of cooling fans shall be automatically and sequentially controlled by temperature sensing devices. A manually operable switch shall be connected in parallel with automatic control contacts. Controls shall be enclosed in a cabinet located on the side of transformer 60 inches or less above base.
 2. Cooling Fans: Propeller type, with aluminum blades and TEFC motors, direct drive. Motor circuits shall be individually fused or thermally protected. Fans shall have OSHA fan guards.
 3. Fan Control: Thermally operated winding temperature control devices.
- E. Provisions for Future Forced Air Cooling: Include the following provisions where future forced air cooling is required:
 1. Top-Liquid Temperature Sensing on Liquid-Filled Transformers: Thermally operated control device with thermal element mounted in a well, and provisions for mounting control cabinet, conduit, and fans.
 2. Winding Temperature Sensing on Dry-Type Transformers: Insulated wells in all 3 coils for future installation of sensors directly in air ducts of each coil to monitor coil temperature, and provisions for future mounting of cooling fans, control cabinet, and conduit.
- F. Windings: Copper or aluminum.
- G. Provide fully insulated neutral terminal for wye-connected windings.
- H. Equip each transformer with a permanent stainless steel nameplate which includes serial number, shop order number, transformer class, number of phases, frequency, kVA rating, primary and secondary voltage, tap voltages, connection and vector diagrams, manufacturer's name, percent impedance, temperature rise, weight of core, coils and fittings, weight and volume of fill liquid (if applicable), and BIL of high and low voltage windings.

2.03 DRY-TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications" and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
 - 1. Enclosure: Indoor, ventilated.
 - 2. Enclosure: Outdoor, ventilated.
 - 3. Enclosure: Totally enclosed, nonventilated.
 - 4. Insulation Class: 220 degrees C.
 - 5. Insulation Temperature Rise: 80 degrees C maximum rise above 40 degrees C.
 - 6. Insulation Temperature Rise: 115 degrees C maximum rise above 40 degrees C.
 - 7. Insulation Temperature Rise: 150 degrees C maximum rise above 40 degrees C.
 - 8. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
 - 9. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
 - 10. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.
- B. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.
- C. Impedance: 5.75 percent unless otherwise indicated.
- D. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.
- E. Surge Arresters: Low voltage type, factory installed and connected to low-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.04 CAST COIL DRY-TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications," and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
 - 1. Enclosure: Outdoor, ventilated, weather resistant.
 - 2. Insulation Class: 155 degrees C.
 - a. Core shall be constructed of miter-cut, high-grade, grain-oriented, non-aging silicon steel. Core leg cross section shall be of cruciform shape to conform to the inside geometry of a round coil. Core laminations shall be free of burrs and stacked without gaps. The core framing structure shall be rigid construction and so designed to provide full clamping pressure upon the core and to provide points for applying blocking and jacking to support the coils.
- B. Construction: Both HV and LV windings shall be of copper or aluminum conductors. Primary and secondary windings shall be of the same material. HV and LV windings shall each be separately cast as one rigid tubular coil, and arranged coaxially. Each cast coil shall be fully reinforced with glass cloth, and cast under vacuum to ensure complete void-free resin impregnation throughout entire insulation system. Coils shall be supported by cast epoxy bottom supports and space blocks and spring-loaded top blocks to absorb thermal expansion and contraction of the coils. There shall be no rigid mechanical connection between HV and LV coils.
 - 1. The windings must not absorb moisture, and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures

- from -40 to +40 degrees C and shall be capable of immediately being switched on after such storage without pre-drying.
2. Core and coil shall be supported on resilient mounting that shall effectively dampen vibration to the transformer enclosure.
- C. Bus and Termination: Terminations shall be of the manufacturer's standard and shall incorporate a functional design which provides appropriate current density and bolting surface capability. Aluminum conductor-to-copper-bus transition shall be by bolt-less connections using DuPont Detaclad (or equal) explosively bonded aluminum-copper plates, to which the aluminum conductor shall be welded, and the copper silver soldered.
1. Outdoor, weather-resistant, ventilated enclosure shall be provided. The base shall be of welded structural steel (11 gauge, minimum) to permit jacking, rolling, and skidding in any direction, and shall have 2 ground pads. Removable panels shall be provided for access to the tap connections, disassembly for moving and installation in limited space, and for inspection and maintenance. Front and rear panels shall be provided with top and bottom weather-resistant ventilation grills to provide adequate cooling and to prevent rain and snow from entering the enclosure.
- D. Insulation Temperature Rise: 80 degrees C maximum rise above 40 degrees C.
- E. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
- F. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.
- G. Impedance: 5.75 percent unless otherwise indicated.
- H. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.05 PAD MOUNTED TRANSFORMERS

- A. Comply with ANSI/IEEE C57.12.22 and with the following features and ratings:
- B. Comply with ANSI/IEEE C57.12.26 and with the following features and ratings:
1. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
 - a. Insulation Temperature Rise: 65 degrees C.
 - b. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
 - c. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
 - d. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.
 2. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for de-energized use, with position indicator.
 3. High-Voltage Terminals: Arranged for radial feed, with 3-phase, 2-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
 4. High-Voltage Terminals: Arranged for loop feed with 3-phase, 4-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.

5. Primary Fuses: Current limiting type in dry-fuse holder wells, mechanically interlocked with oil switch to prevent disconnect under load.
6. Surge Arresters: Comply with NEMA Standard LA 1, Distribution Class, supported from tank wall within high-voltage compartment, one for each primary phase.
 - a. Provide Ohio Brass Co. metal-oxide type surge-arresters with ethylene propylene housing. Provide a barrier around the arresters which complies with Power Company's requirements.
7. Separable Insulated Connectors: Insulated bushing, parking stand, feed-through bushing, and dead-front elbow-type lightning arrester for each high-voltage terminal. Provide 3 portable insulated bushings for parking-energized load-break connectors on parking stands.
8. Secondary Feeder Breaker: Molded case type, mounted in secondary compartment; frame, trip, and interrupting ratings as indicated; complying with UL Standard 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures."
9. Impedance: 5.75 percent unless otherwise indicated.
10. Accessories: Provide the following accessories:
 - a. One-inch drain valve with sampling device.
 - b. Dial-type thermometer.
 - c. Liquid level gauge.
 - d. Pressure-vacuum gauge.
 - e. Pressure relief device, self-sealing with indicator.
 - f. Mounting provision for low-voltage current transformers and potential transformers.
 - g. Busway opening in low-voltage compartment.
 - h. Alarm contacts for above gauges.
 - i. Key interlock on HV compartment door.

2.06 LIQUID-FILLED SUBSTATION TRANSFORMERS

- A. Conform to ANSI/IEEE Standard C57.12.00, "General Requirements For Liquid-Immersed, Distribution, Power, and Regulating Transformers," and C57.12.13, "Conformance Requirements for Liquid Filled Transformers Used in Unit Installation Including Unit Substations," and the following requirements:
 1. Insulating Liquid: Mineral oil conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
 2. Insulating Liquid: Silicone insulating liquid, UL listed as a "Less Flammable" transformer insulating liquid. Liquid shall have the ability to extinguish small arcing and shall have a minimum fire point of 330 degrees C, a maximum convective heat release of 350 Btu per cubic foot when tested in accordance with ASTM standards, and a minimum dielectric strength of 35 kV.
- B. Insulation Temperature Rise: 65 degrees C.
 1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
 2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
 3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.
 4. Basic Impulse Insulation Level: 110 kV for 15.0 kV class.

- C. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high-voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- D. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA.
- E. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA/FA.
- F. Cooling System: Equipped for future forced-air cooling; Class OA/FFA.
- G. Impedance: 5.75 percent unless otherwise indicated.
- H. Accessories: The following accessory items are required:
 - 1. Drain Valve: 1-inch drain valve with sampling device.
 - 2. Dial-type thermometer.
 - 3. Magnetic liquid level gauge.
 - 4. Pressure-vacuum gauge.
 - 5. Pressure relief device: Self-sealing, with indicator.
 - 6. Upper filter pressure connection.
 - 7. Alarm contacts for above gauges.
 - 8. Grounding and bonding components complying with UL Standard 467, "Grounding and Bonding Equipment."
 - 9. Vacuum-Pressure Bleeder: Outdoor units only.

2.07 POLE-MOUNTED TRANSFORMERS

- A. Comply with applicable NEMA, ANSI, and REA standards.
- B. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus."
- C. Insulating Temperature Rise: 65 degrees C.
 - 1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
 - 2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
 - 3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.
- D. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage with tap changer accessible from top through a handhole cover.
- E. High-Voltage Terminals. Cover mounted high voltage porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.
- F. Low-Voltage Terminals: Porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.
- G. Impedance: As indicated.

- H. Accessories: Provide the following accessories:
1. ANSI support lugs (hanger brackets).
 2. Lifting lugs.
 3. Oil: Fill plug with cover ground strap.
 4. Tank ground pad.

PART 3 - EXECUTION

3.01 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

END OF SECTION

SECTION 16334 - MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Medium voltage switchgear and associated auxiliary equipment, and includes the following:
1. Metal-clad circuit breaker switchgear.
 2. Metal-enclosed interrupter switchgear.
 3. Fuses.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each product specified.
 2. Shop Drawings for each switchgear lineup and accessory component. Include dimensional plans, sections, connection details, and elevations showing minimum clearances, installed devices, major features, and materials lists.
 3. Wiring Diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
 4. Time-Current curves for power fuses.
 5. Protective relay settings for protective relays.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- C. Power company approval for switchgear interfacing with power company connections: Submit one copy of product data signed by power company.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Metal Enclosed Interrupter Switchgear:
 - a. Eaton

2.02 MEDIUM VOLTAGE SWITCHGEAR, GENERAL REQUIREMENTS

- A. Factory assembled, factory tested, with functions and circuit assignments for each bay, and types, characteristics, and ratings of busses and disconnecting, and protective devices as indicated. Switchgear shall conform to NEMA Standard SG5, "Power Switchgear Assemblies," and entire switchgear lineup shall be engineered, fabricated, and tested by nameplated manufacturer of major electrical components.

City of Flint WPC

Aeration System Improvements

SRF No. 5696-01

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1. Circuit breaker type switchgear shall comply with ANSI/IEEE Standard C37.20.2, "Standard for Metal-Clad and Station-Type Cubicle Switchgear."
 2. Metal enclosed interrupter-type switchgear shall comply with ANSI/IEEE Standard C37.20.3, "Standard for Metal-Enclosed Interrupter Switchgear."
- B. System Type: Suitable for application on system indicated on Drawings.
- C. Switchgear Ratings: As follows:
1. Nominal System Voltage: 4.16 kV; maximum design voltage: 4.76 kV.
 2. Main Bus Continuous: As indicated on Drawings.
 3. Nominal Interrupting Capacity Class: 350 MVA at 4.76 kV.
 4. BIL Voltage: 60 kV at 4.16 kV class.
 5. 60 Hertz Withstand Voltage: 19 kV (5 kV class switchgear).
 6. Momentary Current Rating: 61,000 amperes, rms asymmetrical.
 7. Short-Time Current Rating: 38,000 amperes, rms symmetrical.
- D. Finishes: Thoroughly clean interior and exterior prior to coating the enclosure and equipment, including bolted joints, with rust inhibiting primer coat. Provide 2 finish coats of manufacturer's standard color finish.
- E. Ground Bus: Copper; silver-plated at connection points extending the entire length of the switchgear.
- F. Main Bus: Tin-plated aluminum.
- G. Main Bus Supports: Porcelain or flame-retardant, track-resistant insulation.
- H. Electric space heater in each compartment of outdoor equipment powered from a separate control power transformer supplied with switchgear.
- I. Low Voltage Wiring: No. 14 AWG minimum, Type SIS, 600 volt, 90 degrees C labeled at each terminal point with designations keyed to wiring diagrams.
- J. Utility Metering Unit: Constructed to suit Power Company requirements and to match and line up with basic switchgear assembly.
- K. Bus transition and incoming line units: As indicated or required.
- L. Load-Interrupter Switch Unit: With fuses equipped to house stationary device rated and arranged as indicated.
- M. Access to Rear Interior of Switchgear: Through hinged doors secured by captive thumb screws.
- N. Auxiliary Unit: Arranged to house meters, relays, controls, and auxiliary equipment as indicated.
- O. Key Interlocks: Where indicated, arranged so interlocking keys are held captive at devices indicated. Where provision for future key interlocking is indicated, provide all necessary mountings and hardware as required for future installation of key interlocking devices.

- P. Instrument Transformers: Conforming to NEMA Standard EI 21.1, "Instrument Transformers for Revenue Metering 110 kV BIL and Less," ANSI Standard C57.13, "Requirements for Instrument Transformers," and the following:
1. Potential Transformer Secondary Voltage Rating: 120 volt with NEMA Accuracy Class of 0.3 with burdens of W, X, and Y. Provide primary and secondary fusing.
 2. Current Transformers Ratios: As indicated with accuracy class suitable for connected relays, meters, and instruments. Provide 0.3 accuracy class for B-0.1, B-0.2, and B-0.3 burdens.
- Q. Microprocessor Based Bus Power Monitoring Device: Where indicated on Drawings, provide a device having the features and functions specified below. The device shall consist of a single microprocessor-based unit capable of monitoring and displaying the functions listed below with the accuracy indicated. The device shall provide the adjustable protection functions indicated, and the capability to communicate data via twisted pair network. The device shall be UL listed and also meet ANSI Standard C37.90.1 for surge withstand.
1. Metered Values (Accuracy Percent Full Scale):
 - a. AC Phase Amperes plus or minus (0.3 percent).
 - b. AC Phase Voltage plus or minus (0.3 percent).
 - c. Watts plus or minus (0.6 percent).
 - d. VA plus or minus (0.6 percent).
 - e. VARS plus or minus (0.6 percent).
 - f. Power Factor (plus or minus 1 digit).
 - g. Frequency plus or minus (0.1 hertz).
 - h. Watt hours plus or minus (0.6 percent).
 - i. VAR hours plus or minus (0.6 percent).
 - j. VA-hours plus or minus (0.6 percent).
 - k. Watt Demand with 10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval).
 - l. Percent THD (through 31st harmonic).
 - m. Voltage -- minimum/maximum.
 - n. Current -- minimum/maximum.
 - o. Power -- minimum/maximum.
 - p. Power Factor -- minimum/maximum.
 - q. Frequency -- minimum/maximum.
 - r. Peak percent THD.
 - s. Peak Demand.
 2. Alarm Functions:
 - a. Voltage Phase Loss.
 - b. Current Phase Loss.
 - c. Phase Voltage Unbalance (5 to 40 percent).
 - d. Phase Voltage Reversal.
 - e. Overvoltage (105 to 140 percent).
 - f. Undervoltage (95 to 60 percent).
 - g. Time Delay for Overvoltage (0 to 20 seconds).
 - h. Time Delay for Undervoltage (0 to 20 seconds).
 - i. Time Delay for Phase Unbalance (0 to 20 seconds).
 3. Outputs shall have separate Form C (NO/NC) trip and alarm contacts with ratings of 10 amperes at 115/240-volt AC.

4. Input ranges of the device shall accommodate external current transformers with ranges from 5/5 through 5,000/5 amperes. Provide external current transformers with rating as indicated on Drawings or sized for incoming service. Above 600 volts, provide fused external potential transformers.
 5. Control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC supply control circuit or separate remote power source (96 to 264 volt AC or 100 to 350 volt DC) where shown on Drawings.
- R. Relays: Comply with ANSI/IEEE Standard C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus." Types and settings with test blocks and plugs, as indicated.
- S. Surge Arresters: Comply with NEMA Standard LA 1, "Surge Arresters." Arresters shall be distribution class with ratings as indicated, metal-oxide type, and ethylene propylene housing. Install in cable termination compartments and connect in each phase of circuit.

2.03 LOAD INTERRUPTER SWITCHES

- A. Stationary mounted in switchgear and including the following features:
1. Arrangement and Rating: Gang operated, rated 600 amperes for continuous duty and for load break. Suitable for operation up to the maximum short circuit rating of integrated switchgear assembly.
 2. Arrangement and Rating: Gang operated, rated 1,200 amperes for continuous duty and for load break. Suitable for operation up to maximum short-circuit rating of integrated switchgear assembly.
 3. Switch Action: No external arc. Interrupting action shall not liberate significant quantities of ionized gas into enclosure.
 4. Switch Construction: Switchblade material shall be copper. Switch and parts including electrical and mechanical connections shall be supported entirely from the interior framework of structure. Switch shall have external manual operating handle with lock-open padlocking provisions for multiple padlocks.
 5. Operating Mechanism: Quick-make, quick-break, stored energy type.
 6. Barriers: Phase barriers for the full length of the blades and fuses for each pole. If a protective barrier is used, it shall be designed for easy removal. The barrier material shall allow visual inspection of the switch with the barrier in place.
 7. Protective shield to cover potentially live parts and terminals.
 8. Fuses: De-energized when switch is open.
 9. Mechanical interlock shall prevent opening door unless the switchblades are open and closing switch if door is open. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing, and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.
 10. Window: For viewing switchblade positions.
 11. Power Fuses: Current ratings as indicated. Each fuse shall have an indicator to show it has blown. Fuses shall meet applicable requirements of NEMA Standard SG 2, "High Voltage Fuses," and the following:
 - a. Fuses shall be positively held in position with provision for easy removal and replacement from the front without the use of special tools.
 - b. Spares: Each fusible bay shall include 3 fuses in use and 3 spare fuses in storage clips.

12. Current Limiting Fuses: Of full range, fast replaceable, current limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from the tube.
13. Expulsion Fuses: Furnished in disconnect type mountings and renewable with replacement fuse units. Gases emitted on interruption shall be controlled and silenced by chambers designed for that purpose.
14. Interrupting rating of fuses at rated system voltage shall be compatible with switchgear being used and source short circuit current capability.
15. Refer to electrical one-line diagrams for additional requirements to be provided with each switch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Anchoring: Anchor each switchgear assembly to two 4-inch minimum channel iron sills by tack welding or bolting.
- B. Sills shall suit the switchgear and shall be leveled and grouted flush into floor.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Arrange and pay for services of a factory-authorized service representative to supervise field assembly and connection of components and testing and adjustment of switchgear components.
- B. Testing: Upon completing installation of system, perform the following tests:
 1. Make insulation resistance tests of switchgear buses, components, and connecting supply, feeder, and control circuits.
 2. Make continuity test of circuits.
 3. Perform test procedures required by the manufacturer's installation and testing instructions.
 4. Perform mechanical and electrical operator tests. Check main and auxiliary contact alignment.
 5. Check arc interrupter operation on load interrupter switches.
 6. Verify key interlock operation.
 7. Test insulation resistance on each phase to ground and from each phase to each other phase.
 8. Test AC over-potential in accordance with applicable ANSI/IEEE standards.
 9. Test contact resistance across each main contact set. Report contact resistance in excess of manufacturer's tolerances.
 10. Test arc chutes for losses in accordance with manufacturer's instructions.
- C. Retesting: Correct deficiencies identified by tests and completely retest switchgear. Verify by the system test that the total system meets the specified requirements.
- D. A training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, and other major components.

END OF SECTION

SECTION 16410 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01600 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Square D Company.
 - 3. Eaton

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."
- B. Fusible Switches: (Heavy-duty) switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- C. Circuit Breaker Switches: Where individual circuit breakers are required, provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient

temperature of 40 degrees C. Provide with AL/CU-rated mechanical screw type removable connector lugs.

- D. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.
- E. Double-Throw Switches: (Heavy-duty) switches of classes and current ratings as indicated.
- F. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977, single- or double-throw arrangement as indicated. For fusible units, provide fuses as indicated.
- G. Service Switches: (Heavy-duty) fusible/circuit breaker switches. UL listed for use as service equipment under UL Standard 98 or 869.
- H. Switches for Classified (Hazardous) Locations: Heavy-duty switches with UL labels and listings for hazardous location classifications in which installed.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel for NEMA 12 and NEMA 4 switches.
 - 2. Molded fiberglass-reinforced plastic for NEMA 4X switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16420 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of motor controllers, including:

1. Combination controllers.
2. Solid-state reduced voltage controllers.
3. Fractional HP manual controllers.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and sizes.
2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):

1. Allen-Bradley Co.
2. Square D Company.
3. Eaton

2.02 MOTOR CONTROLLERS

A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation.

- B. Combination Controllers: Consist of controller and circuit breaker or fusible disconnect switch mounted in common enclosure of types, sizes, ratings, and NEMA sizes indicated. Equip starters with block-type manual reset overload relays. Provide control and pilot devices indicated. Provide 90 degree C SIS or MTW, No. 14 AWG control wiring, tagged at each termination. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with 3 padlocks. Construct and mount controllers and disconnect switches in single NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.
1. The 3-phase starter may be the following types:
 - a. Full Voltage Non-reversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
 - b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
 - c. Two-speed (for two winding motor): Two, 3-pole magnetic contactors, each with its own set of 3 overload devices.
 - d. Two-speed (for single winding motor): Two magnetic contactors, a 5-pole for high speed, and a 3-pole for low speed, each with its own set of 3 overload devices.
 - e. Reduced Voltage (for wye-connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current, and starting (half-winding) contactor shall be sized for at least 75 percent of the full load current and shall be capable of interrupting at least 10 times full load current.
 - f. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay and an autotransformer with taps at 50, 65, 80, and 100 percent, and an integral temperature switch or timing relay to protect transformer windings.
- C. Solid-State Reduced Voltage Controllers: Provide 3-phase, solid-state, reduced voltage motor controllers of sizes and ratings indicated.
1. The controller shall be microprocessor-based and shall provide as a minimum the following modes of operation.
 - a. Soft start with selectable kick-start.
 - b. Soft stop.
 - c. Current limit.
 - d. Full voltage.
 2. The controller shall be self-calibrating and shall automatically adjust itself for line voltage, frequency and current fluctuations. It shall have adjustable starting acceleration and stopping deceleration. Provide transient protection for all controllers furnished.
- D. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in the transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of the unit requirements or provide 150VA rated transformer, whichever is greater. Provide 300 volt rated, oiltight type pilot lights, push buttons with extended guard and black color insert. Equip stop push buttons with half guard and red color insert. Provide 120/6 volt transformer type push-to-test pilot lights with lens color indicated. Provide machine tool type relays, each with 1 spare N.O. contact. Provide 6-digit elapsed time indicators with one-tenth hour increments. When timers are required, they shall be synchronous type.

- E. Fractional HP Manual Controllers: Provide 3-phase and single-phase fractional horsepower manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms, and with one-piece melting alloy type thermal units. Controller shall become inoperative when thermal unit is removed. Provide controllers with double-break silver alloy contacts, visible from both sides of controller, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16421 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's technical product data on NEMA Class 2, Type B motor control centers (MCCs).
 - 2. Submit layout Drawings of MCCs showing accurately scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.
 - 3. Fuse and Overload Sizes: Submit a compiled list of motors, fuse sizes, overload sizes, and types for motors actually installed.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include data and parts list for each MCC and troubleshooting maintenance guide.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with NEMA Standards Pub/No. ICS-2, pertaining to construction, testing, and installation of MCCs, and with applicable NEMA standards for circuit breakers and fuses.
 - 2. UL Compliance: Comply with applicable requirements of UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Standard 845, "Electric Motor Control Centers." Provide MCCs and ancillary equipment which are UL listed and labeled.
 - 3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to construction and installation of MCCs.
 - 4. ANSI Compliance: Comply with applicable requirements of ANSI as applicable to MCCs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
 - 1. Allen-Bradley Co.

2.02 MOTOR CONTROL CENTERS AND COMPONENTS

- A. Provide MCCs and ancillary components of sizes, ratings, classes, types, and characteristics indicated, which comply with manufacturer's standard design, materials, components, and

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construction in accordance with published product information and as required for complete installation and as specified herein.

- B. MCCs: For operation on power source rating indicated, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units, disconnects, and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Provide MCC with NEMA Class 2, Type B wiring, wire units using 90°C SIS or MTW stranded copper wire; No. 14 AWG minimum. Tag all wires at each termination.
- C. MCC Supporting Structures: Factory assembled, dead-front, MCC standard supporting structures with enclosed vertical sections, fastened together to form rigid freestanding assembly. Construct each section 90 inches high with 9-inch horizontal wireways at top and bottom, 20 inches wide, and with 20-inch section depth for front-of-board unit arrangement. Provide NEMA Type 1A enclosure. Provide gasketing on all enclosing sheet steel, wireways, and unit doors. Construct units with 4-5/8-inch wide, 8-inch deep, 90-inch high vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide front-accessible main lug compartment for connection of incoming cables in top or bottom as indicated. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable; provide holes for bolting MCC units to floor.
 - 1. Provide shipping splits in MCC lineup to allow for shipment of maximum 60-inch-long units. Design MCCs so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.
- D. Bus System: Tin-plated aluminum or copper, braced to withstand faults of 65,000 rms symmetrical amperes minimum unless indicated otherwise. Provide main horizontal bus with rating shown, and vertical bus rating of 300 amperes minimum; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Vertical bus shall be full length.
 - 1. Provide 0.25-inch by 1-inch minimum copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish 1 lug per starter unit, minimum.
- E. Starter Units: Draw-out type, magnetic motor starters with fusible switch or motor circuit protector type disconnects, auxiliary control devices, and NEMA size as indicated. Construct each starter unit with doors, unit support pans, saddles, and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Equip with thermal and magnetic overload protection device for each motor circuit, unit-mounted pilot devices, timers, selector switches, indicating lights, and control relays. Provide 1 spare normally open auxiliary contact. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other.
 - 1. Three-phase starter may be following types:
 - a. Full Voltage Nonreversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
 - b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.

- F. Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low-resistance connections.
- G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.
- H. Unit Doors: Securely mounted with rugged concealed-type hinges which allow doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.
 - 1. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.
- I. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of unit requirements or provide 150VA rated transformer, whichever is greater.
 - 1. Provide synchronous type timers unless otherwise noted.
 - 2. Provide 300 volt-rated, oil-tight type pilot lights, push buttons, and selector switches. Equip Start push button with extended guard and black color insert. Equip Stop push buttons with half guard and red color insert.
 - 3. Provide 120/6 volt transformer type push button to test pilot lights with lens color indicated.
 - 4. Provide machine tool type relays, each with 1 spare N.O. contact.
 - 5. Provide 6-digit elapsed time indicators with 1/10 hour increments.
- J. Fusible Switch: Quick-make quick-break, gang-operated switches with positive pressure fuse clips suitable for use with class of fuses required. Provide switches with continuous current rating indicated and with a 100,000 ampere interrupting capability at rated voltage.
- K. Motor Circuit Protector: Adjustable trip magnetic-only instantaneous molded-case circuit breakers for use in starter units. Provide a continuous current rating of at least 125 percent of the motor full load current and an interrupting capacity of 65,000 amps symmetrical. Provide a field adjustable instantaneous trip unit capable of being adjusted from 7 to 13 times motor full load current.
- L. Circuit Breakers: Factory assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole and with fault-current limiting protection; ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees. Provide with AL/CU rated mechanical screw type removable connector lugs.
- M. Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide 2 finish coats of manufacturer's standard color baked-on enamel finish.
- N. Where existing motor control centers are shown to be modified including new circuit breakers, or new sections to be added, furnish device net connections, terminations, and programming within the

existing PLC located in the existing motor control centers(XP1, XP4, P4W, P4E and P7-upper P7-lower) to incorporate these breakers into the existing PLC and panelview display located on the face of the existing motor control centers.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16440 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Lighting panelboards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
 - 2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
 - 3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. General Electric
 - 2. Eaton.
 - 3. Square D Company.

2.02 PANELBOARDS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-

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turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated.

- C. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.
- D. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- E. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.
- F. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.
- G. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

SECTION 16450 - BUSWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Busways are defined as electrical distribution systems consisting of bus bars installed within protective enclosures. Busways are comprised of straight lengths, fittings, and devices.
- B. Section includes the following:
 - 1. Branch circuit.
 - 2. Outdoor feeder.
 - 3. Indoor feeder.
 - 4. Indoor plug-in.
 - 5. Service entrance.
 - 6. Plug-in devices.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Dimensioned layout Drawings of busway systems including, but not limited to, offsets, cable tap boxes, and transformer connections. Show accurately scaled busway with locations of supports and fittings, including firestops and weather seals. Indicate spatial relationship of busways to other associated equipment.
 - 2. Wiring Diagrams: Submit wiring diagrams for busways, including electrical connections to feeders and distribution conductors. Differentiate between portions of wiring which are manufacturer installed and those portions to be field installed.
 - 3. Product Data: Submit manufacturer's data for busways, including sizes and types of enclosures, finishes, bus joints, bar configurations, temperature rise above ambient, and electrical ratings and characteristics. Include short circuit rating.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with NEMA Standards Pub./No's. BU 1, "Busways," and BU 1.1, "Instructions for Safe Handling, Installation, Operation and Maintenance of Busway and Associated Fittings Rated 600 Volts or Less."
 - 2. UL Compliance: Comply with requirements of UL 857, "Electric Busways and Associated Fittings." Provide busways which are UL listed and labeled.
 - 3. IEEE Compliance: Comply with IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to construction and installation of busways.
 - 4. ANSI Compliance: Comply with applicable requirements of ANSI C2, "National Electrical Safety Code," pertaining to metal enclosed bus.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Cutler-Hammer Group, Eaton Corporation.
 2. Distribution Apparatus Div., Crouse-Hinds Corp.
 3. Siemens-Allis, Inc.
 4. Square D Company.

2.02 MATERIALS AND COMPONENTS

- A. Provide busway systems of sizes, types, and ratings indicated, complete with, but not limited to, conductor bus bars, electrical insulators, enclosures, flanges, elbows, offsets, tees, cable tap boxes, weatherheads, transformer connections, power take-off sections, reducers, expansion joints, end enclosures, and other components and accessories needed to form complete systems.
- B. Outdoor Feeder Busway: Provide complete outdoor feeder busway distribution system; low impedance, factory fabricated weathertight galvanized steel housings with sealed seams, drain holes with removable plugs, of types, sizes and ratings indicated. Provide a 50 percent rated internal ground bus. Equip with bolted section joints, gasketed joint covers, and splice plates. Insulate bus bar conductors with Class B (130 degrees C) rated material except at section joints. Silver-plated bus bar conductors at electrical contact surfaces. Temperature rise in busways not to exceed 55 degrees C rise above 40 degrees C ambient temperature when operating at rated load current. Select busway where it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short-circuit currents in compliance with NEMA short circuit current ratings for feeder busways. Finish busways with 2 coats of manufacturer's standard color.
1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.
- C. Indoor Feeder Busway: Provide complete indoor feeder busway distribution system, low impedance, factory fabricated and assembled. Provide a 50 percent rated internal ground bus. Select busway with ventilated housings constructed of sheet steel with baked-on enamel finish, bottom cover welded to side "C" channels, and top cover bolted to side channels, of types, sizes, and ratings indicated. Equip with bolted section joints and splice plates; with bus bar conductors silver-plated at electrical contact surfaces, and insulated except at section joints. Temperature rise in busway not to exceed 55 degrees C rise above 40 degrees C ambient temperature when operating at rated load current. Select busway so it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short circuit currents in compliance with NEMA short-circuit current ratings for feeder busways. Finish busways with 2 coats of manufacturer's standard color.
1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.
- D. Indoor Plug-in Busway: Provide complete indoor plug-in busway distribution system; low impedance, factory fabricated and assembled. Provide a 50 percent rated internal ground bus. Select busway with nonventilated housing constructed of not less than 22-gauge sheet steel with baked-on enamel finish, bottom cover welded to side "C" channels, and top cover bolted to side channels, of

types, sizes, and ratings indicated. Provide plug-in outlets on 24-inch centers with maximum of 5 openings per side for 10-foot section; openings protected by hinged doors which fold back when plug-in devices are installed and swing back into place when plug-in devices are removed. Equip with bolted section joints and splice plates; with bus bar conductors silver plated at electrical contact surfaces, and electrically insulated except at section joints. Temperature rise in busway not to exceed 55 degrees C rise above 40 degrees ambient temperature when operating at rated load current. Select busway where it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short-circuit currents in compliance with NEMA short-circuit current ratings for plug-in busways. Finish busways with 2 coats of manufacturer's standard color.

1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.
 2. Plug-in Devices: Provide plug-in devices, compatible with plug-in busways, in types, sizes, and ratings as indicated, and as recommended by busway manufacturer. Polarize plug-in units for maintaining correct phase orientation. Select enclosures of not less than 18-gauge steel, bonderized both inside and out, and finish with single coat of manufacturer's standard color. Provide means of fastening plug-in devices to busway housings with bolted clamping device. Equip units with safety grounding springs for electrically grounding units to busway housings.
- E. Busway Components: Provide busway components including crosses, elbows, closures, and reducers, in types, sizes and ratings indicated, which are compatible with busway sections and as recommended by busway manufacturer.
- F. Supports and Accessories: Provide busway supports and accessories, including hangers and anchors as indicated and as recommended by busway manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION OF BUSWAYS

- A. Install busway expansion fittings at those locations where busway crosses building expansion joint.
- B. Install integral fire stops where busway penetrates fire-rated walls and floors. Seal between busway and opening and around opening with fire-rated sealant not less than wall or floor fire ratings.
- C. Install integral weatherseal where busway penetrates exterior wall or roof. Provide appropriate flange and seal around openings to maintain weathertight installation.

END OF SECTION

SECTION 16497 - FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of fuses specified, including:
 - 1. Class L time-delay.
 - 2. Class RK1 time-delay.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties, and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristics curves, and mounting requirements.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting Capacity Class K Fuses." Provide overcurrent protective devices which are UL listed and labeled.
 - 2. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering fusable devices which may be incorporated in Work include:
 - 1. [Bussmann](#) Division, Cooper Industries.
 - 2. Commercial Enclosed Fuse Co.
 - 3. Littelfuse, Inc.
 - 4. Shawmut Division, Gould, Inc.
 - 5. Reliance Fuse Division, Federal Pacific Electric Co.

2.02 FUSES

- A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard

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design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

- B. Class L Time-Delay Fuses: UL Class L time-delay fuses rated 600 volts, 60 Hertz, 800 amperes, with 200,000 rms symmetrical interrupting current rating for protecting transformers, motors, circuit breakers.
- C. Class RK1 Time-Delay Fuses: UL Class RK1 dual element time-delay fuses rated 600 volts, 60 Hertz, 400 amperes, with 200,000 rms symmetrical interrupting current rating for protecting motors and circuit breakers.

2.03 EXTRA MATERIAL

- A. Spare Fuses: For the types and ratings required, furnish additional fuses, amounting to 1 unit for every 10 installed units, but not less than 1 set of 3 of each kind.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16529 - HAZARDOUS MATERIAL DISPOSAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, equipment, and services necessary to fully complete removal of hazardous materials specified herein including, but not limited to:
 - 1. Removal of scheduled equipment from OWNER's premises.
 - 2. Verified disposal of scheduled hazardous material.
 - 3. Verified disposal of contaminated equipment.
- B. A complete description of hazardous material is given in Hazardous Material Schedule included in this Section.

1.02 HAZARDOUS MATERIAL DISPOSAL CONTRACTOR

- A. Hazardous Material Disposal Contractor performing this Work (hereinafter referred to as CONTRACTOR) shall be experienced in the handling, disposal, clean up, and documentation of PCB capacitors, mercury filled pressure switches, Lead cables and Lead materials, and PCB light fixture ballasts. CONTRACTOR shall provide insurance certificates for performing this Work at levels of coverage as specified in Conditions of the Contract. Insurance policies shall not contain pollution exclusion clauses for performing Work required under this Contract. CONTRACTOR shall provide insurance certificates that cover environmental pollution Work for performance under this Contract and shall hold harmless from and indemnify OWNER and ENGINEER against claims, suits, actions, costs, counsel fees, expenses, damages, judgments, or decrees by reason of any person or persons or property being damaged or injured by performance of CONTRACTOR during the progress of this Work.

1.03 PERMITS, INSPECTIONS, AND LICENSES

- A. Procure permits, licenses, approvals, and other documents which are required for processing removal, transporting, and disposal of hazardous material and equipment specified on Schedules. CONTRACTOR shall observe and abide by requirements of Federal, State, and local laws, rules, regulations, and/or ordinances applicable to the services to be performed. If changes occur with respect to such laws, rules, regulations, or ordinances which interfere with execution of this Contract, CONTRACTOR shall comply with these changes and shall obtain any additional permits, licenses, approvals, or other documents required by such changes to allow timely completion of this Contract. CONTRACTOR shall pay fees for these documents when such fees are required.

1.04 PAYMENT

- A. An invoice shall be prepared by CONTRACTOR once disposal Work has been completed. Payments to CONTRACTOR will not be made until written verifications of disposal are submitted to ENGINEER.

1.05 SCHEDULE

- A. Work shall be done between the hours of 8:00 a.m. and 4:00 p.m. local time, Monday through Friday, except holidays, as agreed upon with OWNER.

PART 2 – PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 PROCESSING, REMOVAL, AND DISPOSAL OF HAZARDOUS MATERIALS

- A. Removal: CONTRACTOR shall remove and transport from OWNER's premises PCB capacitors, mercury filled pressure switches, Lead cables and lead materials, and PCB equipment as described above and as noted on drawings, equipment described on Schedules, and any contaminated debris generated by execution of this Contract, as soon as liquid, equipment, or debris is taken out of service. It is not acceptable to store any portion of removed Lead material on OWNER's premises while rest of Lead material is being taken out of service. CONTRACTOR shall load materials on a vehicle provided by CONTRACTOR and shall transport this material from OWNER's premises to disposal site(s). CONTRACTOR shall provide waste hauler manifest. It shall be CONTRACTOR's responsibility to thoroughly clean up and decontaminate hazardous material spilled during loading and transporting operations.
- B. Disposal: Hazardous liquid and hazardous solids designated by CONTRACTOR shall be transported by CONTRACTOR to an EPA-approved facility and disposed.
- C. Name of hazardous material facility site to be used shall be submitted to ENGINEER.
- D. After destruction of hazardous liquids and/or solids, CONTRACTOR shall submit to ENGINEER a "disposal certificate" indicating that destruction of hazardous materials has been completed in compliance with Federal, State, and local regulatory requirements.

3.02 Contaminated equipment shall be transported by CONTRACTOR to an EPA-approved facility.

- A. Name of hazardous contaminated equipment incineration site to be used shall be submitted to ENGINEER.
- B. After delivery of contaminated equipment and materials to incinerator site, CONTRACTOR shall receive and submit to ENGINEER a "manifest of acceptance" of contaminated material and "disposal" certificate" indicating that destruction of contaminated equipment has been completed in compliance with Federal, State, and local regulatory requirements.

END OF SECTION